FIRE ECOLOGY

GUIDE TO ENVIRONMENTALLY SUSTAINABLE BUSHFIRE MANAGEMENT IN RURAL VICTORIA

The information in this publication has been prepared for CFA by Helen Bull of obliqua pty ltd.

FE 10/2011

CONTENTS

Cover image: Austral Grass Tree, *Xanthorrhoea australis*, regeneration after fire. Photo courtesy of Owen Gooding

ABOUT THIS GUIDE

Purpose of this Guide

The purpose of this Guide is help users working in the rural landscape (the Country Area of Victoria) to make bushfire planning and operations as (environmentally) sustainable as possible.

This Guide is specifically aimed at preparedness and prevention, as well as managing fire to maintain or improve biodiversity (regime management).

This Guide can be used at any scale, from the property to the local, municipal or state-wide level.

Who may find this Guide helpful?

This document has been developed as a reference to guide the work of CFA staff that assist brigade members and others to deliver CFA's vegetation management services to the community, as shown in the following table.

While this Guide may be used directly, its primary purpose is to provide a resource that can be used to develop further tools, training and guidance for integration in relevant CFA programs.

This Guide may also be of benefit to other users including:

- Integrated Fire Management Regional Network managers
- rail and road managers
- municipal fire, emergency and biodiversity staff
- organisations that provide services to rural landowners (DSE, DPI, CMAs and not-for-profit)
- private landowners.

	CFA positions							
Services	CFA policy and planning staff	Community safety managers	Operations officers	CFA vegetation management officers	CFA fire safety officers	CFA community development staff	CFA wildfire instructors	CFA brigades
Contribute to municipal fire management planning	●	●	●	●	●			●
Contribute to other strategic vegetation management projects	●	●	●	●	●			
Provide advice on vegetation management at the property or small reserve level				● (strategic level)	● (land use planning)	● (primarily home protection)		●
Lead or contribute to development of prescribed burn plans or other vegetation management treatments			●	●			●	●
Develop or contribute to policy or state-wide guidance on vegetation management	●	●	●	●	●	●	●	●
Train others in vegetation management	●					●	●	

Relationship of this Guide to other programs

This Guide builds on and brings together in one document information obtained from a range of sources, including fire safety and environmental training programs and guidelines developed by CFA and the Department of Sustainability and Environment (DSE).

This Guide, which focuses on rural fire management, complements and builds on guidance provided for public land that is the responsibility of DSE.

Sustainability in fire management on public land, which is the responsibility of DSE, is guided by the *Code of practice for fire management on public land* (DSE 2006).

The Code requires the avoidance and minimisation of harm to the environment during fire management operations, rehabilitation of damage, and implementation of ecologically appropriate fire regimes.

Regime management on public land, which is the responsibility of DSE, is guided by tools developed through the Victorian Fire Ecology Program, which is a partnership between DSE, Parks Victoria and CFA. These tools form the basis of Step 6 of this Guide.

How this Guide implements the 2009 Victorian Bushfires Royal Commission recommendations

This Guide contributes to the implementation of the recommendations of the 2009 Victorian Bushfires Royal Commission as follows.

Recommendation	Contribution
43	
The Department of Sustainability and Environment conduct biodiversity mapping identifying flora, fauna and any threatened species throughout Victoria and make the results publicly available. The format used should be compatible with that used for Bushfire-prone Area mapping.	This Guide provides information on how to use this mapping in fire management decision-making.
61	
The State and Commonwealth provide for municipal councils adequate guidance on resolving the competing tensions arising from the legislation affecting roadside clearing and, where necessary amend environment protection legislation to facilitate annual bushfire-prevention activities by the appropriate agencies.	This Guide provides information on how to resolve existing tensions in roadside vegetation management and other vegetation management situations.

ABOUT SUSTAINABLE FIRE MANAGEMENT

What is sustainable fire management?

Sustainable fire management principles

Why manage fire sustainably?

What is sustainable fire management?

Sustainable fire management meets community safety objectives for protecting life and property while:

- avoiding or, if that is not possible or practical, minimising harm to the environment, including the quality of air, land, water and biodiversity
- maintaining or improving biodiversity (through regime management), where practical
- using regime management to reduce the occurrence and intensity of bushfire across the landscape
- meeting legal and policy obligations for environmental care.

Sustainable fire management principles

- Fire management activities have the potential to harm the environment through pollution of air, water and land, damage to biodiversity, and use of water and other scarce resources.
- Harm should be managed through avoiding harm. If that is not possible or practical, steps should be taken to minimise harm through reducing its impact, rehabilitating affected areas or compensating for the harm caused.
- Fire management activities also have the potential to be of benefit to the environment. For example, weed control can improve environmental values as well as reducing fire fuels.
- Opportunities to protect and improve the environment should be identified as part of every fire management activity.
- Fire is a natural part of the Australian environment. Fire of the appropriate regime (frequency, intensity, season, extent and type) is necessary for the health of most native vegetation and the habitat it provides.
- Protecting the environment is an important part of protecting the community, which depends upon the environment for its life and livelihood. Where practical, fire should be planned to achieve both environmental and community safety outcomes.
- Fire management should be guided by an understanding of the environmental assets present on a site, the possible effects of fire and fire management on these assets, and an assessment of options based upon risk.
- Environmental information should be obtained from science-based tools and confirmed with relevant experts.
- Using the ‘precautionary principle’, lack of information on environmental assets and their needs should not prevent fire management from being carried out with care, but monitoring should be undertaken to learn from the experience.
- All fire management activities should be monitored and data provided to government databases to ensure that the wider fire management community is able to learn from these experiences.

Why manage fire sustainably?

There is strong community (including brigade) support for protecting the environment.

This is backed up by legislation and policy at the local, state and commonwealth levels.

Environmental legislation and policy

Key environmental legislation and policy relevant to bushfire management in rural areas is summarised in Appendix 1. CFA personnel can obtain further information from the obligations register, which forms part of CFA's environmental management system.

Environmental legislation and policy generally aim to achieve:

- clean air
- clean and sufficient water for the community and the environment
- stable and productive soil
- viable populations and diverse communities of flora and fauna
- functional, sustainable ecosystems.

At times, fire management may be in conflict with these requirements. This Guide outlines steps that will assist users to identify and manage potential conflicts.

Fire management policy and the environment

Fire management policy documents emphasise the need to manage risks to the environment appropriately.

The *State fire management strategy* (Government of Victoria 2009) outlines a vision for the future of fire management in Victoria that delivers a healthy environment as well as fire safety outcomes.

The *Living with fire strategy* (Government of Victoria 2008) provides directions for achieving this vision, including better integration of ecological needs in fire management planning to promote ecosystem health and resilience.

The *Fire ecology strategic directions 2009–11* document (DSE 2009b) calls for "increased participation by private land-owners, local councils and relevant statutory authorities in planning and implementing ecologically-sound Fire Management Plans, including ecological burns".

The *CFA environmental care policy* states: "CFA aims to deliver its services in a safe, efficient and effective manner while protecting the environment wherever possible for future generations" (CFA 2003).

The *CFA Chief Officer's Standing Order 16: Environmental care* states: **"**In any activity, CFA members shall consider the effects of their activities on the environment and where practical take steps to minimise negative effects and maximise benefits" (CFA 2005a).

The *CFA Chief Officer's SOP 9-28: Strategy and tactics* states: "Consider the environment in developing your control strategies and in your operations. Seek specialist advice where required to help you with these issues. Include environmental precautions in SMEACS briefings. Be aware of water and debris runoff. If your operations are likely to cause disturbance requiring rehabilitation, notify the appropriate agencies to help a smooth transition to the recovery phase" (CFA 2005b).

Environmental notes in the C*FA Chief Officer's SOP: Prescribed burning* (CFA 2009a) state:

- "The planning of a prescribed burn will be consistent with environmental management standards and practices as outlined in the *CFA Environmental care policy* and *Chief Officer's Standing Order 16 – Environmental care*.
- "The planner must seek advice on matters of conservation significance, which need to be addressed in a prescribed burn operation, including threatened flora and fauna. This includes ideal fire intervals identified in ecological burning strategies.
- "Plan any use of class A foam in accordance with CFA procedures and avoid its use near watercourses and certified organic farms.
- "The prescribed burn must be planned to manage the impact of smoke on the community. Appropriate notifications should be made in advance.
- "Plan control lines to minimise soil disturbance, and plan for rehabilitation of control lines where necessary after the burn has been declared safe."

USING THIS GUIDE

Guide steps

This Guide is divided into eight key steps for taking environmental issues into account when planning and implementing fire management in the rural landscape. These are shown in the following diagram.

- Steps 1 to 6 set out how to identify what is needed to avoid or minimise environmental harm and maintain or improve biodiversity.
- Step 7 contains guidance, including case studies, on how to use this information for sustainable fire management in a range of typical scenarios faced by CFA and rural land managers.
- Step 8 provides guidance on monitoring, learning and improving performance.
- Sources of information and assistance are listed for each step. The appendices include a glossary to assist with any unfamiliar terms.

The Guide is designed to be modular, allowing users to use only the sections applicable to their requirements. However, it is recommended that users check Steps 1 to 6 before using Steps 7 and 8.

Skill requirements and roles

Use of this Guide directly, particularly Steps 6 and 8, requires some skills in environmental as well as fire management.

To ensure appropriate skills are available, before using the Guide users should clarify who will provide and assess the environmental information to be taken into consideration.

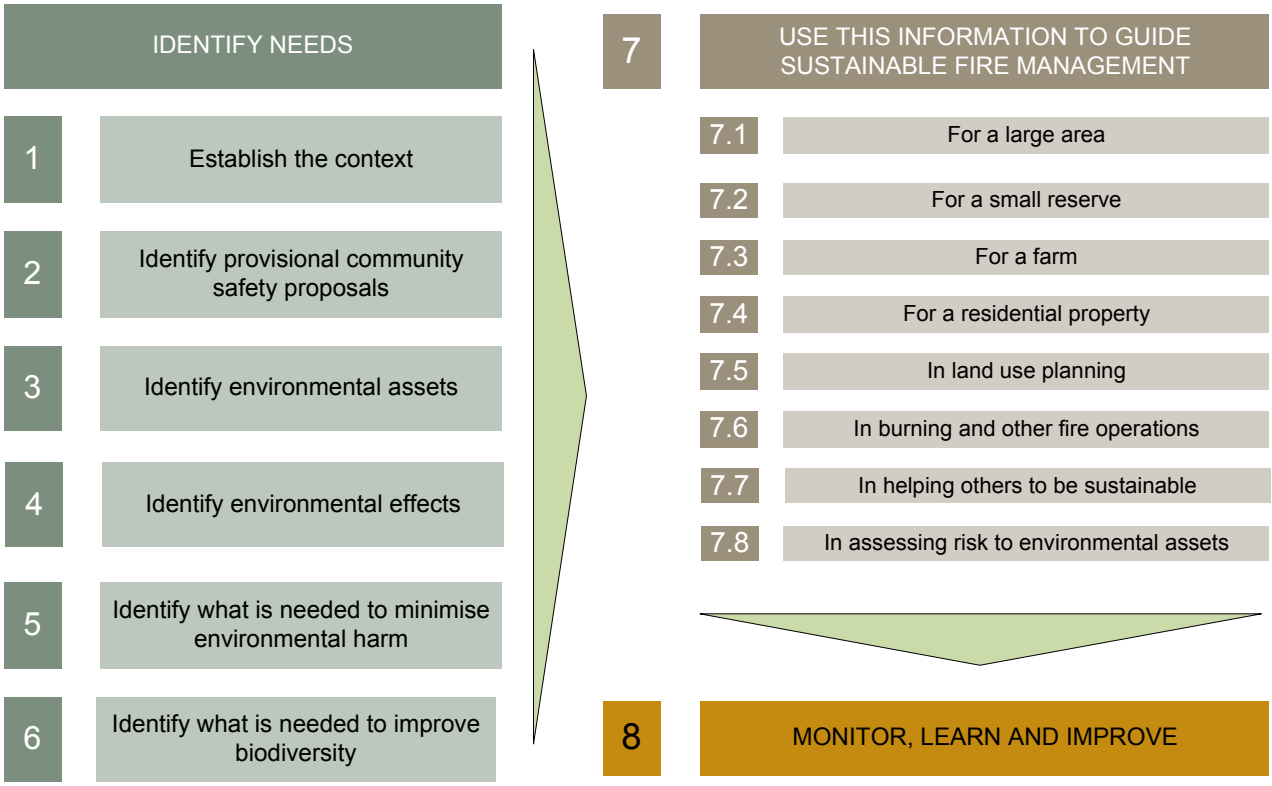
Guide users should seek advice and data from published sources (including those listed in the appendices), DSE's or the local council's biodiversity experts, or ask the land manager to do this. For example, CFA's vegetation management officers across the state work closely with local DSE and council biodiversity officers to obtain information on environmental needs when reviewing fire prevention plans and preparing burn plans.

Alternatively, a team approach may be the best way to provide those skills and share the workload. For example, a 'local fire management plan' is being prepared to cover both public and private land in the Cape Liptrap area in South Gippsland. The team preparing the plan includes CFA, DSE, Parks Victoria, local council and Field Naturalists, ensuring a mix of fire and environmental skills. The success of many of the projects highlighted in the case studies is largely due to the cooperative approach taken.

Status of tools

Some tools outlined in this Guide including those used in Steps 6 and 8 are still under development. It is important to verify and supplement predictions provided by the tools through consulting with experts and monitoring the results of vegetation management operations

Guide Steps



Step 1:

Establish the context

This step will assist you to identify the area you need to take into account, the broad land management objectives that fire management objectives need to complement, and the history of fire management or other disturbance to the vegetation.

1.1 Identify the area that you need to take into account

The site you are working with may be a residential block, a farming property, a park or reserve, a road or rail corridor, a local area or a municipality.

The fire management works that you plan or implement on this land may have effects on the environment beyond the boundaries of the land that you are directly dealing with.

For example, fire management may affect the waterway downhill of your site. The site may be home to wildlife that requires continuous cover in order to reach other parts of its home range. Or the site may support an invasive weed that, if slashed, may spread elsewhere.

It is important that you define the planning area that you need to consider to ensure that you take all relevant environmental issues into account.

The size of this planning area will vary, depending upon the community safety issues (Step 2), the environmental assets (Step 3) and environmental effects (Step 4) to be considered. Further information is provided in these steps.

1.2 Identify broad management objectives for the site and surrounding area

It is important that your fire management proposals are integrated with and contribute to achievement of the community safety, environmental and other management objectives for the land you are working on, and the surrounding area that it may affect.

Community safety objectives may be found in:

- municipal fire prevention plans (which are being replaced by municipal fire management plans)
- reserve management plans
- local government planning schemes for the relevant zone or overlay (e.g. Wildfire Management Overlay).

Environmental management objectives may be found in a range of documents, including those listed in the following table.

Land managers may have additional objectives that are not documented. It is important that these be documented and included in the planning process.

Planning for	Key sources of environmental objectives
Large areas, e.g. municipal level	Regional catchment strategies Regional biodiversity and native vegetation strategies River health strategies Roadside management plans Pest management strategies
Small reserves	Land use recommendation reports (Land Conservation Council, Environment Conservation Council, Victorian Environment Assessment Council) Park and reserve management plans (which may also help guide management of connected vegetation)
Farms	Property management plans, including whole farm plans Conservation agreements such as Land for Wildlife, Trust for Nature, or Native Vegetation Credit (offset) agreements Local government planning schemes for the relevant zone or overlay (e.g. Environmental Significance Overlay, Vegetation Protection Overlay or Significant Landscape Overlay)
Residential property	Local government planning schemes for the relevant zone or overlay (e.g. Environmental Significance Overlay, Vegetation Protection Overlay or Significant Landscape Overlay)
Operations	Park, reserve or property management plans Local government laws (e.g. relating to air quality, roadside disturbance)

1.3 Identify the fire and disturbance history

Fire and disturbance history can help you to assess the likelihood of fire in the future and to identify the fire needs of native vegetation.

Collate information on the history of bushfire or planned fire (noting the year, season, intensity and patchiness of the fire if possible) or estimate from site assessment. Note any other significant disturbance to vegetation such as regular fire management, logging, grazing, drought or insect attack.

It is often difficult to determine fire history in the rural landscape. Sources of information include the *Fire Risk Register* managed by municipalities. Refer to Appendix 1-2 for further information on data sources.

Step 2:

Identify provisional community safety proposals

This step will assist you to identify provisional community safety proposals using science-based tools.

2.1 Identify human assets and treatment options

Identify:

- human assets likely to be affected by bushfire
- the likely risk (likelihood and consequences) posed by bushfire to these assets
- site-specific community safety objectives that will assist protection of life and property, including the level of risk that is acceptable and practical to manage
- how success in achieving these objectives will be measured
- treatment options for achieving these objectives (including personal behaviour) and management of assets and vegetation.

Tools that may help you to do this are listed in Appendix 2-1.

The proposals that you identify in this step should be considered as provisional until you can assess their environmental implications.

Case study: Nillumbik Shire Council

Professors Hill Reserve is a four-hectare site located in Warrandyte North that is managed for conservation of its significant flora and fauna.

The surrounding area supports extensive native vegetation and a mixture of high and low-density housing. The overall fuel hazard has been assessed as 'extreme' over much of the reserve.

Nillumbik Council, in consultation with CFA, has identified this as an area where, under severe fire weather conditions, fires may occur that pose a significant threat to life and property.

One option for reducing a bushfire's impact on houses is to create an asset protection zone with an overall fuel hazard of 'moderate' for a depth of 60 metres in the reserve. This treatment is predicted to reduce the radiant heat impact from a fire in the reserve to 'low'.

Other vegetation management options include reducing fuel over a wider area, but to a higher overall fuel hazard rating, or accepting a higher level of radiant heat exposure.

Candling at Professors Hill Reserve

Step 3:

Identify environmental assets and their significance

This step will assist you to identify environmental assets that may be affected by the provisional community safety proposals identified in Step 2 and their significance.

Environmental assets that may be affected (positively or negatively) by fire or fire management include the air, land, water and the biodiversity they support. These assets may be located on the site or some distance away. Sources of information on environmental assets and their significance are listed in Appendix 3-1.

To prevent the risk of vandalism, the public should communicate the location of significant environmental assets in a way that precludes identification.

Biodiversity

Biodiversity assets

'Biodiversity, or biological diversity, is the variety of all life forms on earth including the different plants, animals and micro-organisms, their genes, and their terrestrial, marine and freshwater ecosystems'.

Source: DSE 2009c

Biodiversity assets, which may be negatively affected by fire or fire management, may be located on land or in waterways. They include the following.

Communities and species

- Threatened (EPBC Act/FFG Act or Ecological Vegetation Classes (EVCs))
- Species listed on the DSE Threatened Species Advisory List
- Other regionally or locally rare or endemic species
- Protected under treaties (JAMBA/CAMBA)
- Fire sensitive (see Step 6)
- Charismatic (e.g. platypus, koala, orchids).

Other sites of biodiversity significance

- Wetlands, other waterways and the marine environment
- Biosites (sites of biological significance)
- Reference areas, old growth, heritage rivers, refugia
- Policy areas, e.g. flagship areas and biolinks
- Land subject to conservation agreements, e.g. Trust for Nature, Land for Wildlife, Bush Tender, EcoTender, Bush Broker and native vegetation offset sites.

Biodiversity assets that may benefit most from fire or fire management include fire-prone species or communities. Refer to Step 6 for further information.

Biodiversity priorities

In order to prioritise, it is important to be able to determine the most significant biodiversity assets.

The following table summarises the most significant biodiversity assets from a state-wide perspective.

Sources of information on significant assets are listed in Appendix 3-3.

Conservation status	Ecological Vegetation Classes (EVCs) EVCs that are 'Endangered' at the bioregional level (Bioregional Conservation Status) Species/communities Listings under EPBC Act or FFG Act Endangered/Critically Endangered Victorian Rare or Threatened (VROT) status Listings under treaties for migratory species (JAMBA, CAMBA and Ramsar) Flagship areas and biolinks identified in the Land and Biodiversity White Paper (DSE 2009c) Other categories assigned 'very high' conservation status in the Native vegetation framework (DNRE 2002a and Appendix 3-2)
Potential impact of fire management	Most of the asset (EVC or species records or sensitive habitat) occurs within the area to be treated or downstream in an area likely to be affected by fire management. The proportion affected will vary with the asset concerned.

Other biodiversity assets of importance

Other assets may be important from a regional or local point of view and should also be considered.

There are an increasing number of private landowners and authorities (such as councils and water boards) that are entering into agreements to manage native vegetation on their land for environmental and business outcomes. For example, through schemes such as DSE's Bush Broker, landowners are contracted to maintain native vegetation in perpetuity to offset native vegetation removed under a planning permit. Similarly, Trust for Nature covenants require ongoing native vegetation protection and Landcare funding requires protection of native vegetation for a 10-year period. Inappropriate fire or fire management could not only affect the biodiversity value of vegetation managed under these agreements but also have an impact on the landowner's business.

Flora and fauna need continuity of vegetation of appropriate growth stages to meet their needs for food, shelter, breeding and migration. Therefore, even small or narrow strips of native vegetation may be locally important.

At a site level, waterways, tree hollows, rocks, logs and other woody debris provide important habitat. A large proportion of significant species are associated with these habitats.

Single trees are also important. As noted by VEAC (2010), "Single trees contribute to the viability of wildlife populations by providing habitat and connectivity between larger patches, and they perform a number of other ecosystem functions such as the mitigation of salinity and soil erosion and aiding in nutrient cycling. Single trees in agricultural landscapes are utilised by many guilds of birds (Fischer et al, 2002), and are important landscape features for bats (Lumsden et al 2005) and arboreal mammals (van der Ree et al 2004)".

VEAC (2010) also confirms the importance of roadsides, riparian zones and small blocks of native vegetation in many of Victoria's heavily cleared bioregions. Roadside vegetation provides a substantial proportion of the native vegetation and often the only remaining habitat in the most heavily cleared bioregions.

Land, waterways and water assets

Clean, stable and productive land is important to agriculture as well as the environment. Land that is most vulnerable to fire or fire management is steep, erodible and affected by salinity or acidity.

Waterways, including rivers, creeks, lakes, estuaries, wetlands and groundwater, provide clean water for domestic, industrial and agricultural use, recreation, food, fibre, energy, carbon pollution reduction, a range of diverse habitat and a range of other benefits.

All wetlands are important areas for conservation of wildlife, including species protected under international treaties. Wetlands are also important places for storage of carbon, contributing to carbon pollution reduction. Notable wetlands in Victoria include the Gippsland Lakes, Werribee sewage treatment works, the volcanic lakes in the Western District and wetlands along the Murray River.

Rivers have an important environmental role in the wider landscape. They:

- replenish floodplains by depositing soil and nutrients
- have healthy river bank vegetation, which stabilises banks, filters water and slows erosion
- move carbon from decomposing material on the floodplain to wetland storages
- replenish groundwater storages
- provide and link a diversity of habitats to support a variety of plants and animals.

The 2002 assessment of river health found that only 27 per cent of Victoria's major rivers were in good or excellent condition and 34 per cent were in poor or very poor condition (DNRE 2002b).

The report card for 2009 (DSE 2010a) indicates that while there have been substantial improvements in river health since 2002, the quality of water (particularly in the lower reaches of many rivers) does not meet objectives set out in the *State Environment Protection Policy (Waters of Victoria).*

This makes it increasingly important that CFA continues to minimise its impact on waterways and the vegetation and other habitat it provides.

Air assets

Clean air is critical to community health. EPA monitoring carried out in 2008 against the standards set out in the *Ambient Air Quality National Environment Protection Measure (AAQ NEPM)* indicates that Victoria has relatively clean air (EPA 2009).

Step 4:

Identify possible environmental effects

This step will assist you to identify the potential effects of your provisional fire management proposals on the environmental assets you ascertained in Step 3.

The fire management works that you plan or implement may have effects on the environment beyond the boundaries of the land that you are directly dealing with. For example, fire management may affect the waterway downhill of your site. The site may be home to wildlife that requires continuous cover in order to reach other parts of its home range. Or the site may support an invasive weed that if slashed may spread elsewhere.

In working through Step 4, it is important to identify any 'offsite effects'. Sources of information on environmental effects are listed in Appendix 4-1.

Vulnerability of environmental assets in the rural environment

Recent studies confirm that Australia's biodiversity is under considerable pressure from vegetation clearing, pests and weeds, highly modified and overcommitted water resources, widespread use of fertiliser and other chemicals, changed fire regimes, urbanisation, mining, and over-harvesting (VEAC 2010). Climate change, with higher temperatures, reduction in water flows and increases in extreme weather events, will add to these pressures.

The effect of disturbance is increased as native vegetation becomes more fragmented. Smaller areas of vegetation have a larger perimeter to core area ratio, increasing the exposure of native vegetation, waterways and the wildlife they support to environmental conditions (such as fire, drought, and climate change), human influences, weeds, grazing and predators.

Isolated patches support fewer and lower densities of wildlife. There is a greater chance of isolated populations becoming extinct as a result of the effects of events such as drought or fire or other disturbance.

However, isolated patches, as well as linear corridor and single paddock trees, are important in biodiversity conservation because they provide habitat as well as 'stepping stones' to other areas of habitat.

All small or linear patches of vegetation, including small reserves or bush blocks, roadsides and river frontages, are particularly vulnerable to disturbance. On private land, there are additional pressures from use of water and native vegetation (e.g. collection of timber for personal use), which can reduce vegetation condition.

Because of this vulnerability, it is particularly important that fire management be carried out in a way that does not further increase the pressure on native vegetation and waterways and the habitat it provides through reducing habitat quality or connections.

VEAC (2010) provides some guidance on the sensitivity of vegetation to disturbance. This report notes that the main determinant of ecosystem health is the extent of remnant native vegetation (which also determines how well the remnants are connected).

VEAC divides Victoria's bioregions into three main groups: most cleared, moderately cleared, and least cleared.

This rating of bioregions can be used to provide a landscape-scale guide to the vulnerability of vegetation to management activities (such as fire management) that may reduce vegetation quality or connection between patches. Particular care should be taken to avoid harm in the most-cleared bioregions.

Victoria's environment is stressed

The *Victorian Catchment Condition Report* (VCMC 2007) found that most of Victoria's catchments were rated moderate to poor in a number of assessment categories, reflecting a general decline in condition of land, water and biodiversity since 2002.

Approximately half of Victoria's native vegetation has been cleared, including 80% of private land (VEAC 2010).

Vegetation on private land supports about 30% of Victoria's threatened species (CSE 2008).

Victoria has the highest proportion (48%) of sub-bioregions in Australia in poor condition, with four out of Australia's five most cleared bioregions found in western Victoria (CES 2008).

54% of remaining vegetation is fragmented. Only 6% of fragmented landscapes are in conservation reserves (VEAC 2010).

88% of the 2.72 million native vegetation patches in Victoria are less than one hectare in size (VEAC 2010).

Victoria is losing native vegetation at a rate of some 4000 hectares each year, mostly from endangered grasslands (VEAC 2010).

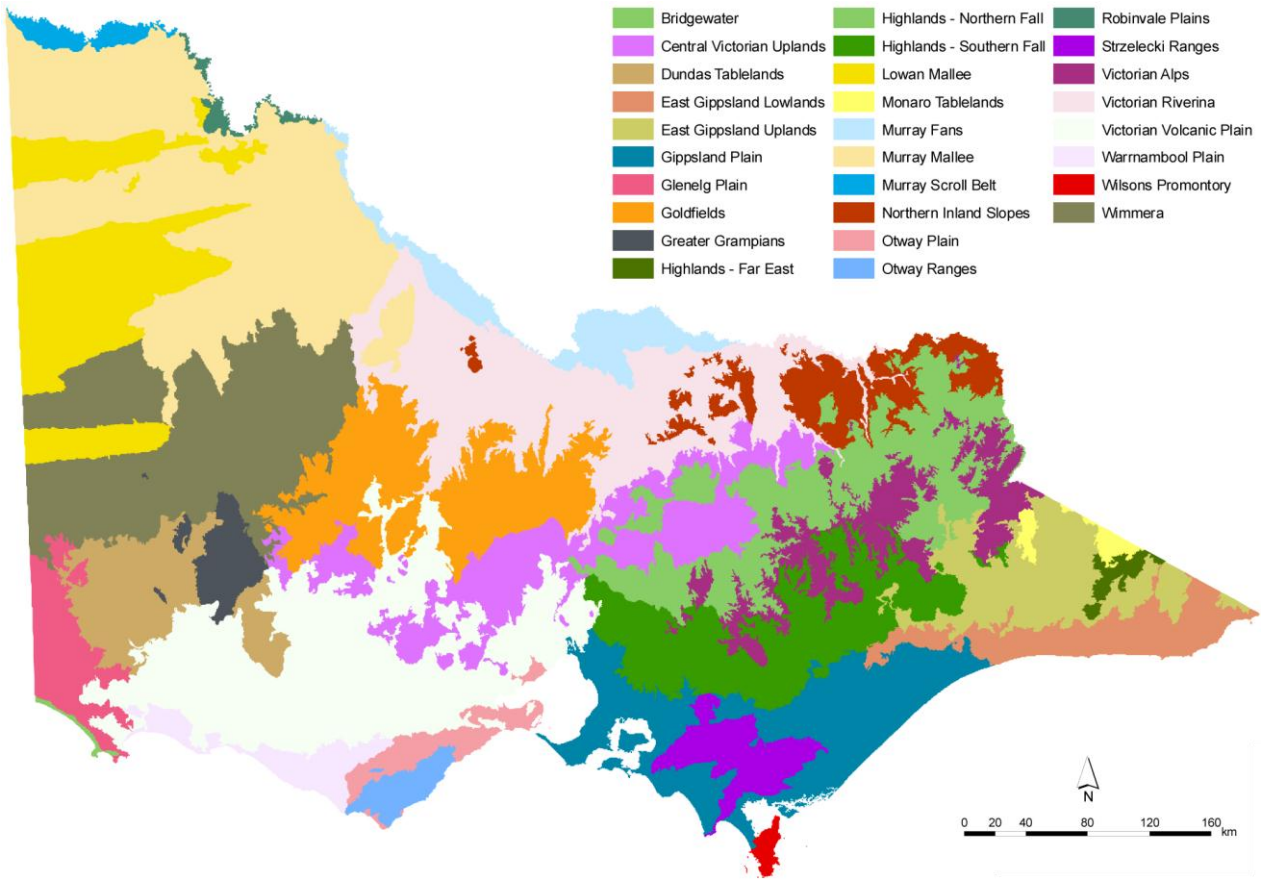
Victoria is losing vegetation quality at the rate of 15,830 habitat hectares each year, 80% of this from private land (VEAC 2010).

The highest number of threatened species in any one region in Australia occurs in north western Victoria (VEAC 2010).

Exotic species represent about 30% of Victoria's flora (VEAC 2010).

One-third of Victoria's major streams are in poor or very poor condition. Two-thirds of wetlands have been either lost or degraded, mostly on private land (VCMC 2007).

Bioregions

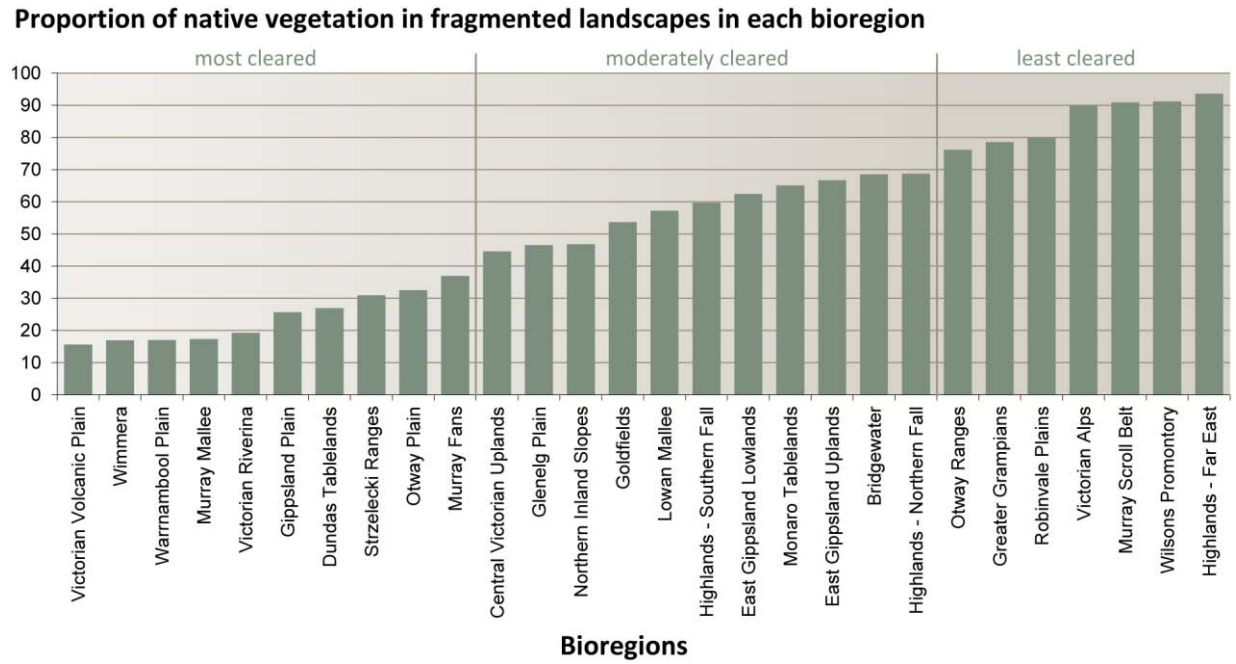


Source: DSE Victorian Biodiversity Strategy 2010–2015

Biogeographical regions (bioregions) are large, geographically distinct areas of land characterised by landscape-scale natural features and environmental processes that influence the function of entire ecosystems.

Bioregions provide a useful means to report on underlying complex patterns of biodiversity for regional-scale conservation planning.

Bioregions are separated by physical characteristics such as geology, natural landforms and climate, which are correlated to ecological features, plant and animal groupings and landscape-scale ecosystem processes. There are 28 bioregions in Victoria.



Source: VEAC Remnant Native Vegetation Investigation Discussion Paper (2010)

Fire management effects

Fire and fire management can have positive effects on the environment.

For example, fire applied at the appropriate frequency, intensity, season and extent can help to maintain or improve plant and habitat diversity. Fire can be used to stimulate weed regeneration, which can then be treated using herbicide or other methods.

Inappropriate fire and fire management can cause harm to the environment.

The following table lists potential effects on the environment from fire and fire management.

Summary of environmental assets, effects and events

Environmental assets	Effects From FFG listed threatening processes (DSE 2009d) unless indicated by #	Initiating events Events that lead to threats and impact on assets
Communities and species Protected under treaties (JAMBA/ CAMBA) Threatened (EPBC Act/ FFG Act) Fire sensitive Charismatic (e.g. platypus) Ecological Vegetation Classes (EVCs) Threatened Fire sensitive Other sites of biodiversity significance Soil Water Air	Vegetation degradation Degradation of native riparian vegetation Inappropriate fire regimes Water, water body and waterway degradation Alteration to natural flows Increase in sediment input Input of toxic substances Wetland loss and degradation Loss of habitat Habitat fragmentation Loss of coarse woody debris Loss of hollow-bearing trees Pest impact Weed invasion of native vegetation Pest animal impact Phytophthora cinnamomi #Pollution of air – smoke and greenhouse gases #Soil degradation Chemical change Erosion Loss of nutrients	Fire Bushfire Planned fire Blacking out Vegetation clearance/disturbance from control lines/inappropriate rehabilitation Other infrastructure, e.g. stream crossings Chemical use Retardant Foam Wetting agent Oil/fuel spills Traffic Vehicle use Machine use Aircraft Water Use of environmental water Use of recycled water/salt water

Effects on biodiversity

The effect of fire on plants and animals generally depends upon the fire or management regime and whether they are adapted to it.

Suppression and prevention efforts over the past 200 years combined with the extensive fires of the past decade have meant that the fire regimes in many areas of native vegetation are inappropriate for species and habitat diversity.

'Inappropriate fire regimes' and 'high frequency fire' are listed as potentially threatening processes under the Flora and Fauna Guarantee Act 1988 (DSE 2009d).

Flora

The effects of fire or other disturbance on flora can be predicted by considering the vital attributes of species.

DSE's *Floral vital attributes database* (DSE 2009a) lists for each species a range of characteristics, including how it regenerates after fire (by seed or resprouting), time to reproductive maturity, life span of individual plants, and time to extinction. This information can be used to identify the response of individual species to fire and fire management and, in particular, the frequency of disturbance.

The *interval* between fires or other disturbance possibly has the most significant influence on vegetation composition and structure. Plant species may become locally extinct if disturbance occurs before a plant can reproduce or after individual plants have died out (and their seed store is depleted).

The *season* in which fire management is carried out may affect the plants because of fire intensity as well as timing. Burning or slashing may inhibit flowering and seed set in the following season. Species that regenerate from short-lived seed may require a fire to occur soon after seed set. Good rain after fire can lead to prolific growth of weeds, which can smother native species. Dry conditions after fire may lead to deep-rooted resprouters dominating.

High fire *intensity* may scorch or kill tree crowns and trunks. It may also result in the loss of hollows and logs. However, fire also helps to develop tree hollows, which are important habitat. High-intensity fire may favour germination of plants from seed stored in the soil and with hard seed coats (e.g. wattles).

The risk of harm from fire to roots and tubers in the soil is considered low. For example, Coates et al (2006) concluded that because the tubers of the orchid they studied (*Prasophyllum correctum*) were more than three centimetres below the soil surface and soil heating during a fire "is negligible below the immediate surface… it is unlikely that *mycorrhizal fungi* (associated with the orchid's tubers) are directly affected by grass fires".

Similarly, fire is not thought to kill the water mould *Phytophthora cinnamomi*, which is considered a significant threat to biodiversity and a range of trees and crops. This disease is spread by movement of water and soil; therefore, fire and fire management can spread it quite readily. It is commonly found in areas of poor sub-surface drainage. Early indicators include dead or dying grass trees (*Xanthorrhoea* species).

The *type* of disturbance may also be important. Fire may be preferable to other fire management techniques such as slashing. For example, many plant species can only regenerate following fire and many beneficial effects such as stimulation of flowering (for example, grass trees) are not reproduced by other means (Tolhurst, personal communication). However, hand removal of shrubs may be more appropriate on smaller projects to reduce fuel hazard and to make subsequent burning safer.

The *extent* of fire and the scale and patchiness is also important. Even small unburnt patches provide important refuges for plants to recolonise burnt areas.

Having plants at different life stages (e.g. young, mature and old) across the landscape provides diversity of habitat that improves the capacity to recover from fire or other disturbance. DSE's report on growth stages (Cheal 2010) can be used to help identify growth stages for each Ecological Vegetation Division (EVD).

Fauna

The effects of fire or other disturbance on fauna can be predicted by considering changes in habitat.

MacHunter et al (2009) use four 'response curves' to describe the effects of fire on fauna species. These are:

A – species quickly benefit from fire	These are mostly species that move into the burnt area and remain until the resources that attracted them decline below a threshold level, e.g. some raptors.
B – species show an initial decline following fire and then increase	This is the most likely response and is expected to apply to a large number of species.
C – species show a long-term decline following fire with or without a short-term increase	This response occurs when: • the shrub layer is reduced by fire, providing short-term habitat for species that feed in the open • regeneration of the shrub layer then makes this habitat unsuitable for these fauna species • shrubs thin out over time and these fauna species recover.
D – species decline immediately post-fire and do not recover for very long periods	Repeated burning could produce this response if the fire frequency did not allow the EVD to persist, or the fire intensity was sufficient to remove certain habitat elements that take a long time to be replaced (e.g. hollow-bearing trees).

Adapted from MacHunter et al (2009)

This table shows that most fauna populations can be expected to recover from fire given sufficient time for their habitat to recover (Response B).

MacHunter et al (2009) also list attributes of key fire response species selected for several Ecological Vegetation Divisions, including habitat types and food preferences. These can be used to determine appropriate treatments to minimise harm (see Step 5) or an appropriate fire regime (frequency, intensity, season, extent and type) to promote biodiversity (see Step 6).

Habitat elements that are particularly vulnerable to high fire *intensity*, or fire management, because of the long recovery time include tree hollows and logs.

The *season* of burning or fire management may have an impact on reproduction and dispersal of young, which will be vulnerable to predators. Collett and Neumann (2003) found that burning in spring resulted in no long-term effects on invertebrates found in litter. Although autumn burning resulted in changes, these may have been due to other factors.

The *extent* of fire or activities such as clearance of firebreaks, burning or slashing may remove habitat and important habitat links. Small untouched patches provide important refuges for wildlife to recolonise burnt areas.

Fire is a key tool in biodiversity management. Ideally, a diverse fire regime (of varying intensities, scales, seasons and fire intervals) is needed. This makes the vegetation and the habitat it provides more diverse and more resilient to major disturbances, such as large fires or pest outbreaks. Fire can be provided by bushfire or planned fire.

Effects on land and water

Fire may affect soil temperatures and chemistry. However, Humphreys and Craig (1981) note that papers they reviewed indicated that "quite severe fires both in terms of the energy released and its duration are required to significantly heat the solum to a depth greater than 2.5 cm".

Fire and vegetation removal can change water yield in catchments significantly. Following fire, water runoff from bare and water-repellent soil increases. As plants regenerate they use more water in their active growing stages.

Fire, removal of vegetation and clearance of control lines can result in erosion and reduce the success of regeneration on the eroded site.

Soil that is erodible (e.g. sandy soil), or affected by salt or high acidity, or is located on steep slopes (e.g. greater than 10-15 degrees) is particularly vulnerable to erosion.

Water falling on burnt soil or compacted surfaces can carry soil, nutrients, ash and other debris into waterways. This can change the depth, flow rate, lighting and temperature of the habitat, which may affect its suitability for some species. It can also cause flooding in severe cases.

Hall (1994) flagged the possibility of a long-term loss of productivity in forest soils after noting a 30-fold increase in phosphorus loss after burning. An increase in phosphorus and nitrogen can also be expected in waterways after fire. This may lead to algal blooms and fish kills (Government of Victoria 2003).

These effects (water runoff, erosion and water pollution) can be expected to be less for planned fires compared with bushfire where filtering streamside vegetation is retained.

Fire suppression foam and other chemicals such as herbicides used in fire prevention can also pollute waterways.

Effects on air quality

Small particles in smoke that lodge in the lungs may lead to a range of health effects in sensitive groups (e.g. people with existing heart and lung disease or asthmatics).

A major factor affecting the amount of smoke production from prescribed fires is the area alight at any one time (Tolhurst and Cheney 1999). Overall, the contribution from planned burning to particle levels is small compared with other sources. However, in some rural areas of Victoria, smoke can be quite widespread and visible, resulting in significant community concern (EPA, DNRE and CFA 2001).

Fire and fire management can contribute to carbon pollution and climate change. Fire and planned burning release carbon and other greenhouse pollution to the environment and vegetation removal reduces the absorption of carbon from the atmosphere. This pollution may be wholly or partially offset by absorption of carbon by regrowing vegetation.

Australia's carbon accounting does not include carbon pollution resulting from forest management, cropland management, grazing land management, or revegetation (Department of Climate Change and Energy Efficiency 2010). These activities include fire and fire management. As a result, carbon pollution will not be considered further in this document.

Fire management effects – myth or fact?

Fire management in the rural landscape is often guided by perceptions of risk including judgements on what constitutes a hazard, the level of risk that hazard poses, and how to manage that risk. This can lead to unnecessary pressure on the environment.

Common myths include:

- vegetation management alone will solve the problem
- burning is the best way to solve the problem
- trees are the main problem
- vegetation on roadsides, waterways and rail corridors creates unacceptable risks.

Perceptions about conservation also hamper appropriate fire management. Common myths include:

- fire reduces conservation values in every instance
- small blocks of bush and single trees have no conservation value.

Some points to consider are as follows.

Vegetation management is only one of a number of treatments that may reduce fire risk

Good fire management should use a range of treatments to manage the risk to human life. These include avoiding the risk by not building in dangerous environments, leaving early when properties cannot be defended, increasing the fire-resistance of buildings to improve their ability to provide shelter from a fire, as well as reducing fuel hazards. A multi-pronged approach is more likely to succeed, particularly if one treatment fails. Undertaking alternatives (for example, building improvement) may also enable less vegetation management to be carried out, which will lessen pressure on the environment.

Burning may not be the most appropriate treatment to reduce fire risk

The time required for fuel to return to pre-burn levels in a study conducted in the Wombat Forest (Tolhurst 1994) was:

Surface fuel	2-4 years
Elevated fuel	10 years +
Bark fuel	15-25 years

This study indicates that burning will be of use in medium-term reduction of elevated and, in particular, bark fuel.

However, burning only gives short-term reduction of surface fuel. To reduce surface fuel hazard levels may mean burning more frequently than is desirable for many species, including woody shrubs. Burning to this frequency may be difficult because of resource constraints and the narrow window of appropriate weather conditions. Burning may also increase the germination of weed seeds or bracken, which may increase the fuel load.

Consideration should be given to alternative vegetation treatments, including slashing of understorey and burning of bark (using a technique known as 'candling'). Refer to case studies included in Step 7 for more information on bark reduction.

Threats from trees can be managed

Continuous crown fires have been observed in conifer plantations, but will not be maintained in eucalypt forests unless there is a strong surface fire (Tolhurst and Cheney 1999).

The risk of crown fire and spotting can be significantly reduced where the overall fuel hazard including surface, near-surface, elevated and bark fuels are reduced. In addition, trees may help to reduce the impact of fire by reducing wind speed and by screening embers.

Roadside vegetation may not significantly affect fire behaviour under severe weather conditions

Roadside vegetation may be significant in affecting the safety of the community and fire-fighters using roads in the event of fire. CFA's *Roadside fire management guidelines* (CFA 2007) provide guidance on how this risk can be managed sensitively.

However, in conditions where weather is the dominant factor in determining fire behaviour, roadside or other linear vegetation may have little impact on fire behaviour. Counsel assisting the 2009 Victorian Bushfires Royal Commission concluded from expert evidence about roadside vegetation and fire behaviour that "… in the overwhelming majority of instances, the severe weather conditions on 7 February 2009 … had the effect that roadside vegetation had no significant impact on the overall spread or shape of the fires".

Counsel also concluded that the presence of fallen logs and tree debris on the sides of roads had little impact on fire behaviour.

The relationship between the Forest Fire Danger index and the dominance of fuel and weather in determining fire behaviour is illustrated in the following diagram.

Appropriate fire regimes can improve the condition of vegetation and the habitat it provides

Fire has been a natural part of the Australian environment for thousands of years.

Plants and animals have evolved and adapted to fire. Different species have different approaches. For example:

- Fire-adapted plants regenerate after fire from seeding and resprouting.
- Reptiles survive in burrows, rock shelters, under bark and in unburnt hollows. Birds and mammals may flee the fire or survive in unburnt patches
- Wildlife species return to burnt areas at different rates and times, depending on the availability of their habitat requirements (e.g. food and shelter).

Fire regimes (frequency, intensity, extent, season and type) influence what vegetation and wildlife can live in Victoria. Too much or too little fire can harm native plants and animals and over time can alter the species mix at a site (DSE 2010c).

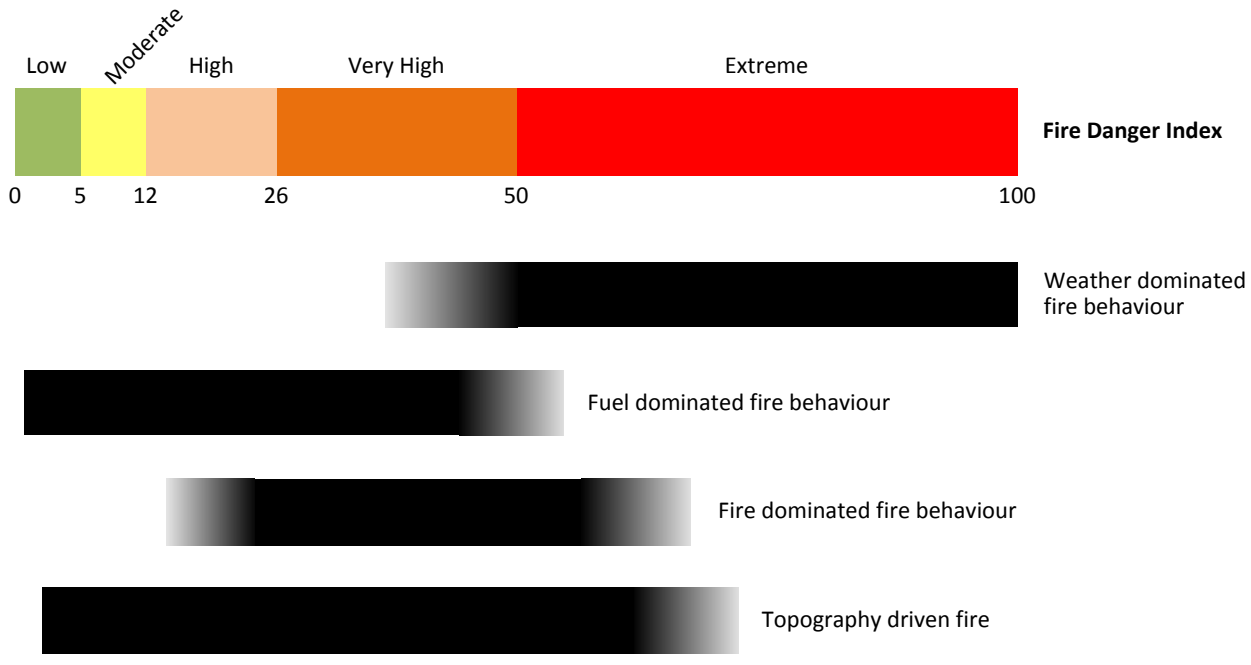
Even small blocks of bush have conservation value

More than one-third (38 per cent) of the total area of native vegetation in Victoria is in patches smaller than 1000 hectares (VEAC 2010).

Suckling (1982) is one author who has concluded that small blocks not only provide habitat but important links between habitat. In a study located in Gippsland, Suckling noted that forest remnants of 50 to 100 hectares supported half the mammal species found in the region.

Relationship between FDI and Fire Behaviour Factor Potential Dominance

Relationship between FDI and Fire Behaviour Factor Potential Dominance



Source: Tolhurst (2010)

Step 5:

Identify what is needed to minimise environmental harm

This step will assist you to identify approaches that will minimise harm to environmental assets from fire management.

Fire management activities such as burning, slashing or other treatments have the potential to harm the environment through pollution of air, water and land, damage to biodiversity, and use of water and other scarce resources.

Environmental assets may also be threatened by inappropriate fire regimes. Information on this issue is included in Step 6.

5.1 Identify environmental assets that need to be protected

Identify the priority environmental assets to be protected from threats using the information collected in Steps 3 and 4.

5.2 Select the most appropriate fire management treatments

Appropriate treatments and decision-making

The most appropriate or sustainable treatments will be those that achieve community safety objectives, while avoiding or minimising harm and maximising benefits to the environment and meeting legal and policy obligations for environmental care.

It may not always be possible or practical to meet some objectives. It is up to the land manager to make fire management decisions based upon the best information available, as they are the ones accountable for the consequences.

Fire safety and conservation need not conflict. Look for 'win-win' outcomes. Both fire and other forms of vegetation management, such as clearing of over-represented shrub layers, can help achieve biodiversity as well as community safety objectives.

Scale and location of treatments

The fire management works that you plan or implement may have effects on the environment beyond the boundaries of the land that you are directly dealing with.

In working through Step 5, it is important to identify any work needed to manage offsite effects.

It is also important to identify work that could be carried out elsewhere to address risks to either the community or the environment. For example, locating fire management works on land that is already cleared, or effective community development programs that encourage residents to manage safety risks on their own land and leave on days of higher fire risk, may reduce the need to rely so much on vegetation management on public land.

Treatment selection and staging

Fire has several environmental advantages over other forms of fire management such as slashing or grazing. These include:

- reduced competition for light, moisture and space
- heat (plant, soil, seed, chemical and physical changes, organic matter, nitrogen, phosphorus, sulphur, pH)
- smoke that may stimulate flowering and seeding
- soil sterilisation (fungi, bacteria, invertebrates)
- soil albedo (dark ash/char), which helps to provide warmth for seed germination (Tolhurst 2010).

Environmental advantages of fire

	Fire	Drought	Flood	Digging	Grazing	Slashing
Competition	●	●	●	●	●	●
Heat	●	●				
Smoke stimuli	●					
Sterilisation	●	●				
Soil albedo	●			●	●	

Adapted from Tolhurst (2010a)

While fire has environmental advantages, burning may not help achieve fire safety objectives. For example, burning of long unburnt bushland may increase the surface and elevated fuel hazard, particularly in vegetation with shrubby understorey, as the native vegetation regenerates. Conversely, intense fire may kill trees, particularly those stressed by drought. Burning may also encourage weed growth that, if left untreated, can restore pre-burn fuel hazard levels within a season.

Burning may not always be practical as many bushland areas have extreme fuel loads. If burnt, the result may be a fire that is too intense and cannot be managed safely.

Also, burning is only possible in short periods of the year and not all brigades have the appropriate resources, skills or the confidence to burn. In these cases, a staged approach (below) may make burning safer and help achieve community safety and environmental objectives.

1	Manual reduction of elevated fuel (shrub layer) either as a boundary break or over the whole burn site.
2	Reduce bark hazard by burning ('candling') in winter.
3	Burn remainder of site in accordance with prescriptions.

5.3 Identify prescriptions to minimise environmental harm

The following strategies can be used to develop prescriptions for fire management operations and monitoring. Further sources of information are listed in Appendix 5-1.

Assets at risk	From	Possible effects	Strategies for minimising risks to the environment	Advice
Air quality	Smoke	Nuisance Health risk to vulnerable groups Visual amenity Road safety Community concern	Plan burn to direct smoke away from community and roads Notifications to community to enable them to avoid smoke Traffic management Mop up promptly	EPA
Land condition	Fire breaks Control lines Burning Other vegetation management	Soil loss Water pollution Regeneration impeded Visual amenity	Use existing tracks, low grades Make control lines and other areas of bare soil only as big as you need them Align areas of bare soil along the contour Stabilise control lines to prevent erosion Avoid ploughing and grading of fire breaks Consider alternatives to machines for control lines, e.g. rakehoe, candling, hoselines Rehabilitate control lines when no longer required	DSE
Water quality and availability	Control lines Burning	Water pollution Loss of environmental flows Loss of habitat Town water supplies	Seek advice, modify plans to avoid impact on waterways, and obtain permits Avoid wetlands, waterways, water supply areas Do not disturb buffer areas Minimise runoff through siting/design of control lines Take care to prevent entry of foam to waterways Minimise water use	CMA Water authority
Biodiversity assets significant trees/species/ communities hollow trees habitat corridors	Control lines Burning Other vegetation management	Loss/damage to habitat Weed invasion Soil erosion Water pollution Community concern Improve habitat/biodiversity	Seek advice, modify plans as appropriate to avoid impact on significant species and habitats, and obtain permits Protect significant assets/exclude from burn or other fire management Carry out burning/other fire management in ecologically appropriate regime where possible Follow CFA guidelines for herbicide use	Council / DSE
Environmental and agricultural assets from weeds/ pests/disease from smoke	Machines Vehicles Foot traffic Smoke	Regeneration of weeds Spread of weeds and disease via soil, water Invasion of predators Increase in overall fuel hazard Community concern Crop taint (e.g. wine grapes)	Seek advice, modify plans as appropriate to avoid spread of weeds, predators and disease Arrange for control of weeds and predators before and after the burn/other fire management Traffic plan to avoid infested areas Vehicle/foot wash downs and responsible disposal of washdown water Plan burns to minimise risk of smoke taint (consider timing, wind direction, size)	Landowner DSE DPI

Step 6:

Identify what is needed to improve biodiversity

This step will assist you to identify what can be done to improve biodiversity using fire and fire management.

This step refers to tools and processes developed by the Department of Sustainability and Environment. These tools are relatively new and further research is needed to refine them.

It is important to test any recommendations through monitoring of the results (see Step 8). This will not only help improve the management of the site being monitored, but also improve the tools for others.

Biodiversity can be improved through, among other things, creating "a mosaic of growth stages of vegetation, across the landscape, in a suitable spatial arrangement, that meets species' needs. This appropriate mix of growth stages needs to be maintained over time. In addition, specific measures need to be in place to protect some 'at risk' species and ecosystems" (DSE 2010c).

The following diagram identifies key steps that can be used to improve biodiversity using fire or other fire management techniques. Sources of information are listed in Appendix 6.

Summary of key steps

6.1	Classify the vegetation
6.2	Is fire appropriate?
6.3	Identify indicator species
6.4	Identify the interval over which fire may be needed in the community
6.5	Adjust this interval for the needs of indicator and significant species
6.6	Identify the ideal fire frequency for this community
6.7	Identify other issues for the ideal fire regime

6.1 Classify the vegetation

- Identify the Ecological Vegetation Classes (EVCs) present on site using DSE's biodiversity interactive map.
- Verify the EVCs present by checking the EVC description on the DSE website against the species list for the site, by inspecting the site, or by obtaining specialist advice.
- Ecological Vegetation Divisions (EVD) and Ecological Fire Groups (EFG) are groupings of EVCs with common requirements and tolerances for fire. Identify the EVD and EFG that each EVC belongs to through DSE (2009i).

6.2 Determine if fire or disturbance is appropriate to the vegetation community

- Identify the EVDs that are either fire dependent or fire influenced using the descriptions of expected fire behaviour for each EVD in Cheal 2010 (Table 2.3).
- Exclude areas where it may be inappropriate to burn (e.g. the vegetation is under stress from prolonged drought or insect attack, or is sensitive to fire (e.g. rainforest), or is unsafe or impractical to burn).
- Check if you are likely to achieve your objectives through use of fire.

6.3 Identify indicator species

Key fire response species give an indication if fire or other disturbance is occurring in timeframes appropriate to the ecological needs of flora and fauna.

Floral key fire response species include species likely to die or be significantly reduced from either very frequent or infrequent fires. Floral key fire response species are used to develop the maximum and minimum tolerable fire intervals (section 6.4) for each EVC as well as any specific habitat features that may need to be created or maintained. They are also used in monitoring to determine if ecological objectives have been met.

Floral key fire response species are determined from DSE's vital attributes database. Appendix 6 contains an explanation of the attributes described in the following paragraphs.

To identify plant species that are most sensitive to fire or disturbance that is *too frequent*, select plants known to be or thought to be on site that have:

- seed availability attributes G and C (reproduce only by seed, and their seed pool is exhausted with a single germination pulse after fire)
- vegetative characteristics V and Y (where sprouting vegetation is non-reproductive)
- the longest juvenile period for the EVC.

To identify plant species that are most sensitive to *infrequent* fire or disturbance, select plants that:

- have the shortest extinction period
- show establishment response I (unable to regenerate beneath a mature canopy) or R (require conditions to establish under mature canopy).

Faunal key fire response species occupy key habitat features that are required to cater for the wider range of species expected on site.

To identify key fire response species and their attributes, refer to Appendix 4 in MacHunter et al (2009). At present, faunal KFRS are only available for some EVDs.

It is unlikely that the fire response of species in a community will differ greatly from that of the key fire response species. Selection of at least five each of floral and faunal key fire response species should give a good indication of the fire response of a community.

6.4 Identify the interval over which fire may be needed in the vegetation community

The *minimum tolerable fire interval* (TFI) refers to the minimum period between fires required to allow all species within the EVD to reach reproductive maturity. This is set by the key fire response species, which take the longest time to reach maturity. These species are adversely affected when fires are too frequent.

The *maximum tolerable fire interval* (TFI) refers to the maximum period between fires for the EVD beyond which some species may become extinct in the area. This is set by the key fire response species with the shortest time to local extinction.

To identify the maximum and minimum tolerable fire intervals (years) for each EVD/EFG, refer to Cheal (2010). These intervals are based upon the fire responses of floral key fire response species (see 6.5 below).

6.5 Adjust this interval for needs of indicator and significant species

Identify the vital attributes of key fire response species and significant flora and fauna (e.g. threatened species), including time to reproductive maturity, time to extinction and tolerance to canopy cover as set out in step 6.3.

Identify significant species that may have requirements outside the tolerable fire interval for the community.

Adjust the tolerable fire intervals if needed to accommodate key fire response species and significant species.

Alternatively, differing fire frequency needs could be met through techniques such as patchy burning.

6.6 Identify the 'ideal' fire frequency for the vegetation community

Identify the history of fire and other disturbance such as grazing or mechanical clearance plus the area affected, patchiness, frequency and intensity.

Identify the area occupied by different growth stages on site for each EVD/EFG using sections 3 and 4 of Cheal (2010).

Determine the area that is theoretically 'available' for burning in the longer term (from an ecological viewpoint) by identifying growth stages that have a greater proportion of the area than expected or optimum for the species being protected. At present there is no target identified for each growth stage in each EVD. This is a management decision and should be confirmed using expert advice.

Determine the area likely to be burnt within the tolerable fire interval by bushfire.

It is difficult to predict the likely occurrence of bushfire. The incidence of bushfire and landscape-scale bushfire is expected to increase due to climate change (Hennessy et al 2006), but community and fire service preparedness is expected to increase following the February 2009 fires, which may to some degree offset the increase in fire incidence across the state.

Determine the area likely to need planned fire within the tolerable fire interval by subtracting the area likely to be burnt by bushfire.

Determine the 'ideal' fire frequency for communities.

The fire cycle is the period of time within which an area equal to the total area of a vegetation type will be burnt and is defined as approximately the mid-point between the upper and lower tolerable fire interval

(= Min TFI + Max TFI)/2)

A broad estimate of 'ideal' fire frequency (expressed as average area or percentage of the total area each year) at a community level can be estimated by dividing the area or percentage of the area available for burning by the fire cycle (in years).

6.7 Identify other issues to be taken into account in developing an ecological fire regime

A fire regime is described by its frequency, season, extent, intensity and type.

The ideal fire regime should take into account the ideal community-level fire frequency (as set out in the preceding section), and the frequency needs of key fire response species and significant species.

The regime should also take into account the needs of species that may influence the season, intensity, extent and type of fire or disturbance.

It should also take into account the effect of fire management on issues identified in Step 4, including:

- drought-stressed vegetation
- weeds and predators
- changes to fuel levels from burning
- alternatives to fire for improving ecological condition and reducing fuel
- grazing and loss of regeneration
- habitat linkages for key fauna species to each growth stage of the vegetation and the important structures within it (e.g. hollows)
- soil, water and air quality.

Case study: 'Ideal' fire regime

The biodiversity officer for Nillumbik Shire Council is working with contractors to develop an ecologically sustainable fire management plan for a four-hectare reserve, Professors Hill Reserve, in Warrandyte North.

Vegetation classification and appropriateness of fire

The site supports three EVCs that are grouped into two EVDs. One EVD is shown in this example. Based on the information provided in Cheal 2010, fire has been and should be a part of these communities (subject to any species-specific requirements or site constraints such as drought).

EVD	EVC	Fire behaviour	Fire needs
Grassy/ Heathy Dry Forest	Grassy Dry Forest Transitional Valley Grassy Forest/Herb-Rich Foothill Forest	Regime of high frequency and very high intensity fires, flammable for most of the year (possibly not winter), rapid recovery post-fire, much regeneration fire-cued	The patchiness of low intensity fires is critical in maintaining sensitive species in the community, as it means that some vegetation, within the fire perimeter, escapes being burnt at such frequent intervals.

Interval over which fire may be needed

The minimum and maximum tolerable fire intervals predicted for Grassy/Heathy Dry Forest is shown in the table below. As the reserve has not been burnt for approximately 60 years, Grassy/Heathy Dry Forest is well outside the tolerable fire interval. This means that this EVD may have lost some species due to lack of fire.

EVD name	Max. TFI (years)	Minimum TFI –high-intensity fires (years)	Minimum TFI – low-intensity patchy burns (years)
Grassy/Heathy Dry Forest	45	15	10

Indicator species

The key fire response species that take the longest time to reach maturity are adversely affected when fires are too frequent. Examples include Swamp Gum *Eucalyptus ovata* var. *ovata*, (20 years to reach maturity), Blackwood *Acacia melanoxylon* and Prickly Currant-bush *Coprosma quadrifida* (10 years to reach maturity).

Key fire response species with the shortest time to local extinction and at most risk from infrequent fires include Narrow-leaf Bitter-pea *Daviesia leptophylla* (20 years to reach possible extinction) and Common Cassinia *Cassinia aculeata* (50 years to reach possible extinction).

Ideal fire frequency

The proportion of the Grassy/Heathy Dry Forest EVD in the different growth stages was identified using the descriptors in Cheal (2010) and is shown below. To promote vegetation diversity, it is proposed in this case that the long-term target for each age class be evenly divided.

Growth stage	Distinguishing features	Current age class (%)	Suggested age class target (%)
Young = Renewal + Juvenility + Adolescence		0	33
Mature		0	33
Waning	Long-lived ground plants maximised	100	33
Old = Senescence	Canopy open Mature shrubs dying and shrub layer opening out		

This assessment shows that:

- the 'young' and 'mature' stages are under-represented in this EVD and the waning/old stages are over-represented
- in theory, 66 per cent of the current waning/old vegetation can be considered available for burning in the longer term.

In this example, it was assumed that there will be no bushfire in this reserve during the planning period, but if there is, then plans to apply fire will be adjusted.

A broad estimate of 'ideal' fire frequency (expressed as average area/year) at a community level can be estimated by dividing the area available for burning by the fire cycle.

Fire cycle = (Max + Min TFI)/2

= 55/2 = 30 years (rounded to the nearest 5) for low intensity fire

Fire frequency for this EVD (approximately)

= available area/ fire cycle

= 66%/30 years

= 2%/year or 11% every 5 years

‘Ideal’ fire regime summary

The following ‘ideal’ fire regime for Professors Hill Reserve was based on consideration of fire frequency needs of individual flora species, and intensity, extent, seasonal and type preferences for all environmental assets.

‘Ideal’ fire regime summary

Asset	Frequency	Extent	Intensity	Season	Type	Other
EVD – Grassy/ Heathy Dry Forest	Initial trial to determine response of drought-affected vegetation following survey of key fire response species (refer to C2) Burn to achieve long-term aim of three growth stages (33% young, 33% mature, 33% waning/old) Burn 11% of area greater than minimum TFI every five years if initial trial successful	Burn small patches (10x10 m max) with long boundary along contour, in a random pattern, excluding areas to be protected	Minimise high intensity fire, which may damage drought-affected tree crowns			
Orchid species	Trial burning of small patches at a range of intervals from 3-10 years (based on Coates et al) to ascertain a frequency that will benefit orchid diversity	Burn small patches (10x10 m max) in a random pattern, excluding areas to be protected	Low intensity fire considered unlikely to damage tubers (Coates et al 2006)	Minimise fire after late April (affect Greenhoods) Avoid spring burns (Corybas and Pterostylis spp)		
Hollow-reliant fauna		Protect trees with hollows Include larger trees in burns to encourage hollow formation	Minimise high intensity fire, which may damage hollows	Minimal disturbance required during winter/spring (nesting and dispersal)		
Shrub-dependent fauna	Retain 20% of old vegetation and introduce fire or disturbance to encourage age class diversity (e.g. three growth stages)	Provide shrub links between hilltop and riparian habitat		Minimal disturbance required during winter/spring (nesting and dispersal)		
Ground cover-dependent fauna		Protect logs Ensure patchy burns to maintain areas of ground cover for recolonisation	Minimise high intensity fire, which may damage logs/ reduce patchiness	Minimal disturbance required during winter/spring (nesting and dispersal)		
Aquatic fauna		Exclude waterways and buffer from burn areas				Protect waterways from runoff
Soil/ water quality		Burn small patches (10x10 m max) with long boundary along contour to minimise runoff/erosion			Use hand removal of shrubs to minimise erosion on steep slopes	Design of control lines; manage blacking out (see ‘Environmental care’)
Air quality		Burn small areas at a time				Use wind direction and notifications to minimise impact on community

Plant indicator species for monitoring at Professors Hill Reserve

As shown in the following table, species that are most sensitive to fire or disturbance that is too frequent (those indicated by blue colouring) have:

- seed availability attributes G and C (reproduce only by seed, and their seed pool is exhausted with a single germination pulse after fire)
- vegetative characteristics V and Y (where sprouting vegetation is non-reproductive)
- the longest juvenile period for the EVC.

Examples include Prickly Currant-bush *Coprosma quadrifida* and Common Cassinia *Cassinia aculeata.*

Species that are most sensitive to infrequent fire or disturbance (those indicated by yellow colouring):

- have the shortest extinction period
- show establishment response I (unable to regenerate beneath a mature canopy) or R (require conditions to establish under mature canopy).

Examples include Narrow-leaf Bitter-pea *Daviesia leptophylla* and Grey Parrot-pea *Dillwynia cinerascens*.

The most suitable key fire response species for monitoring are those labelled 1 (highly suitable) or 2 (suitable).

Refer to Appendix 6-2 for the legend for floral vital attributes

Species	Seed response (PERSEED)	Vegetative response (PERVEG)	Establishment conditions (TIRMK)	Time to reproduction (JUVEN)	Extinction time (SPP LIFE)	Plant life span (INDIV LIFE)	GEOPHYTE	KFRS
Acacia aculeatissima	S	X	I	5	100	MP	N	3
Acacia mearnsii	S	X	I	5	100	SP	N	1
Acacia melanoxylon	S	Y	T	10	100	LP	N	2
Acacia ulicifolia	S		I					3
Acrotriche serrulata		Y	T	5	50	LP	N	2
Cassinia aculeata	C	X	T	5	50	MP	N	2
Cassinia longifolia	S	X	T	5	50	MP	N	2
Coprosma quadrifida	C	V	T	10	100	MP	N	3
Correa reflexa var. reflexa		Y	F	5	50			3
Daviesia leptophylla			I	5	20	MP		2
Dillwynia cinerascens	S	X	I	5	50	MP	N	2
Hovea heterophylla		Y	I	5	100			3

Step 7:

Use this information to guide sustainable fire management

This step provides examples of how to use the information outlined in previous steps to improve the sustainability of fire management plans, operations and advice.

The examples provided in this section all use variations of the following basic 'adaptive management' steps.

7.1 Develop a sustainable fire management plan for a large area

Municipal fire management in grasslands Corangamite Roadside Fire Management Plan

Rail environmental strategy

NCCMA Box Ironbark Plan

This section provides guidance on how to identify and address environmental issues when developing a fire management plan for a large area in the rural or rural-urban landscape.

Examples of plans to which this guidance could be applied include municipal fire management plans, local area fire management plans, road or rail management plans and township protection plans.

This process is built upon Steps 1 to 6 already outlined.

Case study: Municipal fire management in protected grasslands

Adapted from Hill and Bull (2008)

Western Victoria contains some of the most important native grasslands in the state and approximately one-third are located on roadsides. The Natural Temperate Grassland of the Victorian Volcanic Plain is listed under the EPBC Act. These grasslands are home to numerous endangered species, including the Striped Legless Lizard (*Delma impar*).

Fire management in western Victoria focuses on management of fire fuels located on strategic roadsides to supplement work carried out on private property. Brigades have burnt thousands of kilometres of strategic roadsides for road authorities for many years. This work is carried out to help prevent fires from starting and spreading, to assist their control and to make roadsides safer for road users in the event of fire. It is also carried out to help to improve the environmental values of the grasslands.

Plan	Identify the risks (fire safety and environment)	Consult with stakeholders
	Identify the objectives	
	Identify the treatments	
	Incorporate agreed risks, objectives and treatments in the (then) Municipal Fire Prevention Plan	
Do	Implement the treatments	
Review	Check that treatments meet objectives	

CFA staff and brigades in south-west Victoria have been working with DSE biodiversity staff and other partners over the past decade to integrate grasslands management for fire safety and environmental outcomes using the following process.

Their work confirmed what brigades have known for a long time:

- Fire safety and the health of grasslands are both threatened by weed invasion and lack of fire.
- Good environmental management means good fire safety (and vice versa).
- Burning can help achieve both fire safety and environmental outcomes.

Volcanic Plains Grassland showing legless lizard habitat tile.

Risks – Weed invasion

Weed invasion suppresses native vegetation species and changes the habitat for the wildlife it supports.

Weeds can also raise fuel levels substantially. For example, Phalaris can grow to two metres tall, with fuel levels of 29 tonnes/hectare (CFA 2004c). This contrasts with fuel levels of 6 tonnes/hectare measured for native Themeda grasslands during January in an average year.

The probability that a bushfire can be controlled decreases as fuel levels and the corresponding fire intensity increase. The probability decreases significantly at fire intensities greater than 3500 kW/metre (McCarthy and Tolhurst 1998).

As shown in the following table, under average summer conditions, fires that start in exotic grasslands are unlikely to be controlled unless response is rapid. Under these conditions, there is a much higher probability that fires in native grasslands can be controlled.

Grassland environmental quality and fire safety

Predictions are based on average summer day (high fire danger) and bad summer day (very high to extreme fire danger) scenarios for south-west Victoria. Weather parameters are based on local knowledge. Calculations are based upon CSIRO 1997a and 1997b. Pasture is 80% cured (CFA 2001). Fuel loads were determined from visual assessment of 'natural pasture'.

	Native grassland	Mixed native grassland (Some exotic invasion)	Mixed exotic grassland (Some native species)	Exotic grassland
Environmental quality				
Fuel load (tonnes/ hectare)	3	4	5	6
Fire intensity (kW/m)				
Average summer day	2,850	3,800	4,750	5,700
Bad summer day	9,000	12,000	15,000	18,000

Fire regime

Lack of fire is one of the main factors that has contributed to the loss of native vegetation species in grasslands in the south-west and elsewhere (DSE 2003).

Without fire or other disturbance for 5-10 years, tussock grasses dominate the grassland and suppress other species, including lilies and herbs. As tussocks die off, weeds can invade the gaps.

Too-frequent fire may also cause loss of some species. For example, five-year intervals between fires may be most beneficial for Striped Legless Lizard habitat (DNRE 1993).

However, annual burning is reported to have favoured native grasslands on roadsides (DNRE 1999). Morgan and Lunt (1999) note that most species-rich grasslands in south-eastern Australia have a history of frequent burning, with intervals of 1-3 years between burns.

Damage to habitat by fire management activities

Key risks include:

- damage by traffic to soil crusts
- damage by traffic to vegetation and other habitat (such as rocky Striped Legless Lizard habitat)
- preparation of breaks needed to control the burns and to protect fences.

Objectives and treatments

Fire management is carried out in a way that minimises the impact on and, where practical, improves the environment.

CFA vegetation management facilitators now provide DSE with their burn proposals annually for feedback on any biodiversity concerns.

DSE also advises facilitators annually about road reserves where DSE is seeking burns for ecological outcomes.

Fire management is guided by the following objectives and treatments. These are being formalised as a *Fuel break guiding principles* document (DSE 2009g).

Objectives	Treatments (examples)
Community safety is improved	Fuels are reduced by burning grasslands located on strategic roadsides on an annual basis, unless advised otherwise by DSE.
Impact of fire management on the environment is minimised	Ploughing is restricted to control lines three metres wide (unless otherwise approved by roads authority).
	Broad acre ploughing is no longer used to reduce fuels.
	Herbicide use is restricted to control lines three metres wide unless otherwise approved by roads authority, or when applied by 'wick wiper' as part of a weed control program (CFA 2004a and 2004b).
	Traffic through native grasslands is restricted to minimise damage to vegetation, rocky areas and soil crusts.
	Burns are conducted in summer, rather than spring. This can help lizards to take refuge in soil cracks.
	Foam is not used to 'black out' burns.
Grasslands are protected and, where practical, improved and extended	Sensitive areas are excluded from burning or other treatments.
	High-quality native grasslands are burnt at intervals no longer than five years, or otherwise as advised by DSE.
	Exotic grasslands are replaced with native species (Examples are documented in CFA 2004c and 2004d).

Documentation of plans

All risks, objectives and treatments, the person (or agency) responsible, and timelines are documented in a database and mapped (CFA 2004e) and, once agreed are included in the Municipal Fire Prevention Plan and its successor, the Municipal Fire Management Plan.

Benefits of a cooperative and integrated approach

This cooperative and integrated approach to fire management has led to a number of benefits for both fire safety and the environment:

- Subject to weather and resourcing, brigades burn more than 2600 km of roadsides each year for land managers in accordance with approved plans.
- Working relationships between biodiversity experts including DSE and CFA are positive and productive.
- Formal monitoring of burns by brigades has been limited. This presents an opportunity for improvement. However, a comparison of maps has identified a strong correlation between high value native grasslands and annual burning programs. This view is supported by research reported in DNRE 1999 and DSE 2003.
- The value of having an agreed approach to grassland fire management has also been demonstrated during bushfire response. The incident management team used the Southern Grampians Municipal Fire Prevention Plan to plan control lines during the 2006 Mt Lubra fires. The planning process for installation of 73 km of containment lines was assisted by this document as key stakeholders had already agreed to relevant issues, including management of significant grasslands on roadsides. The incident action plan also included guidelines to minimise damage to the grasslands.

Grassland requires suitable burning treatment

Case study: Roadside fire management plan – Hamilton Highway

CFA, councils, VicRoads and DSE have worked together to develop a roadside fire management plan for the Hamilton Highway.

The processes used to develop these roadside fire management plans broadly follow the process outlined in the case study 'Municipal fire management in protected grasslands'.

Assets and risks

The Hamilton Highway provides a fuel break of strategic importance on the Victorian Volcanic Plains. It runs in an east-west direction and is primarily grassland, with isolated exotic plantations. Over the past 20 years, introduced grasses including *Phalaris* have invaded native grasslands on the roadside and intensive cropping has replaced grazing on private property, resulting in a much higher fuel load and spotting potential. With higher fuel loads, increased traffic volumes and reduced volunteer availability, the roadsides are now more challenging to burn.

VicRoads and DSE carried out a vegetation assessment on the Hamilton Highway roadside, identifying several significant native grasslands. These have been classified and mapped as high, medium and low conservation value.

Value	Criteria
High	Relatively intact native vegetation Minimal weed invasion May contain good wildlife habitat
Medium	Modified native vegetation Some weed invasion and loss of some understorey
Low	Roadsides with little or no native vegetation remaining

Objectives

The Hamilton Highway Strategic Fire Management Plan was developed to provide an integrated approach to reducing fuel and maintaining biodiversity values along this roadside. It recognises the contribution that native grasslands can make to reducing fuel loads.

The objectives of the plan are to:

- maintain the Hamilton Highway between Cressy and Darlington as a strategic fire break
- protect the remnant native grasslands and if possible re-establish native grassland areas along this section of the highway
- maintain support and funding through partners
- maintain and support the integrated approach by all agencies for roadside fire management
- use fire as a tool to manage native vegetation and biodiversity conservation values as far as practicable.

Strategies

The plan identifies several strategies to deal with the identified risks. These include:

- burning native grasslands (high and medium conservation value) in late summer/early autumn (after seed fall) every 3-5 years to maintain species diversity. Where these areas are threatened by exotic grasses, they are to be burnt before seed fall from exotic grass
- slashing native grasslands (high and medium conservation value) in late summer/early autumn (after seed fall). Where exotic grass has invaded, these areas are to be slashed in early spring at a height above the native grass
- targeted spraying of *Phalaris* and other weeds in accordance with CFA guidelines to achieve fire protection and environmental benefits
- trialling the control of introduced grasses and revegetation with native grasses
- spraying weed-infested areas around waterways only with 'frog-friendly' chemicals
- reducing weed spread through equipment washdowns and grading or slashing well before or after seed fall
- preparation of fuel breaks in accordance with guidelines, *Management of fuel breaks on medium and high conservation roadsides* (DSE 2009g)
- stakeholder education in partnership with groups such as LandCare.

Brigade work plans

The plan proposes that individual works plans be developed for each brigade area and incorporated in the Municipal Fire Prevention Plan. The works plans will enable brigades to carry out appropriate works in the defined areas with minimal requirement for further consultation.

Works plans are to include:

- an A3 laminated aerial photograph of the brigade area, with all native grassland communities identified by colour coding
- preferred treatment options for high/medium and low sites of conservation value
- traffic management plans.

Monitoring and review

The success of the plan will be monitored to ensure that it:

- is being implemented by the responsible land managers and associated agencies
- is effective in reducing the identified risks
- remains relevant over time.

The plan states that "success will be assessed through reports to the coordinating committee at regular identified intervals".

Case study: Roadside fire management plan – Corangamite Shire

This 30-year plan (University of Ballarat et al 2009) was developed following interest from Cobden and Timboon brigades in reducing fuel loads on strategic fire management roads. It implements an action in the Corangamite Municipal Fire Prevention Plan.

The aim of the plan is to provide on selected strategic fire management roads:

- relatively safe corridors for passage of traffic
- protection and enhancement of native vegetation.

Recommendations were developed using the following process:

- Databases were searched for significant species likely to found on the roadsides.
- Conservation value, fuel hazard and location of assets was assessed by detailed field survey and mapped. All field data is stored in the council's roadside management database.
- Fire effects were considered by reviewing the effects of a burn carried out in 2006.
- Fire regimes (fire frequency, intensity, extent, season and type) were developed based on Ecological Vegetation Classes (EVCs), conservation value, weed status and overall fuel hazard of the roadside.

EVCs within the roadsides were categorised according to their dependence on fire based upon guidelines provided by Kennedy and Jamieson (2007) and unpublished data provided by Parks Victoria for the nearby Otways region.

Three kilometres of roadsides supporting Lowland Forest were categorised as 'fire dependent'. The plan considered that this EVC required fire for regeneration and maintaining biodiversity approximately every 30 years.

Most of the roadside vegetation was categorised as 'fire influenced' or 'fire sensitive'. The plan recommends avoiding burning in fire-sensitive EVCs, as these contain species that are not adapted to frequent fire.

The plan recommends burning 'with caution' in fire-influenced EVCs at a frequency of no less than every 20 years. The plan gives priority to burning segments of low and medium conservation value in fire-influenced EVCs that have high fuel loads and abundant weeds. Priority is not given to burning in these EVCs where conservation value is 'high' as "no specific species requirements have been identified that require burning in the foreseeable future", and because of the risk of fire stimulating regeneration of weeds.

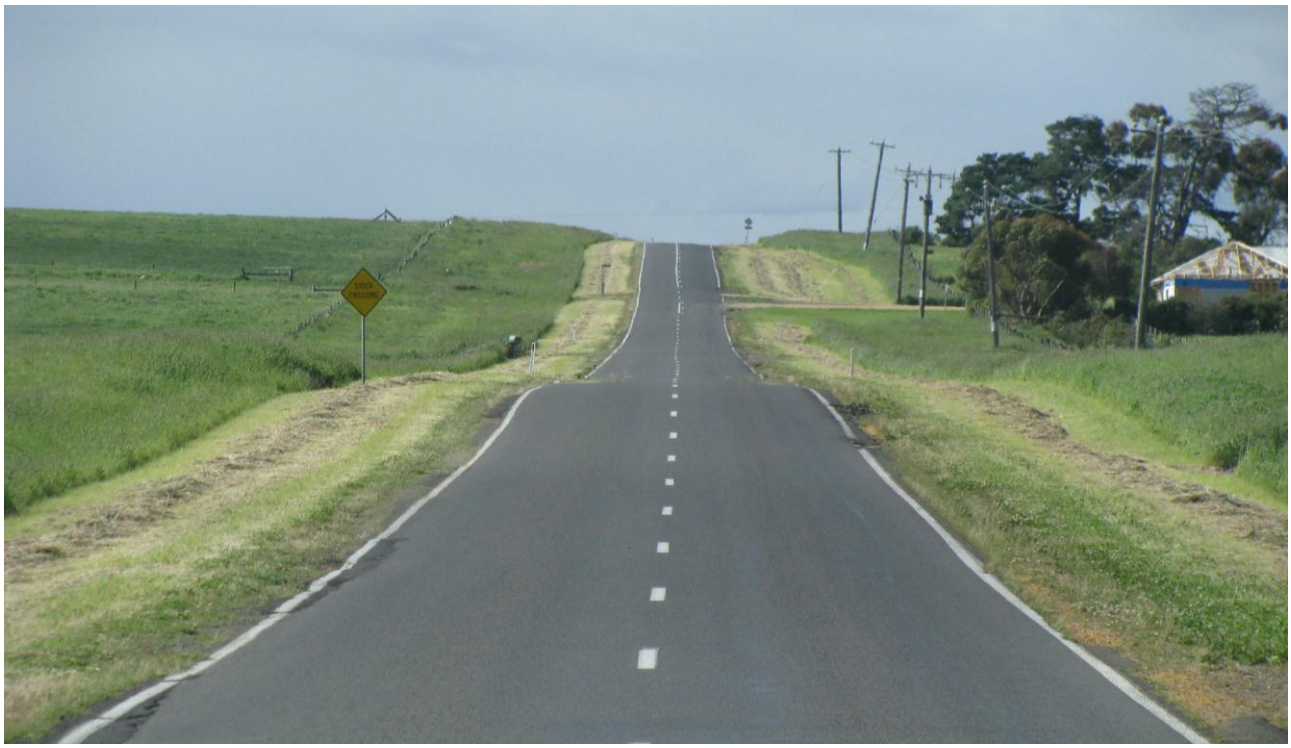
Much of the fuel load along the roadsides considered in this plan is created by weeds such as blackberry, *Phalaris* and Austral Bracken. The plan notes that planned burning may temporarily reduce fuel load, but fuel loads will rapidly increase following fire due to rapid regeneration of these species.

To deal with this issue, this plan integrates weed management in the fire management program.

The burning prescriptions aim to reduce the fire risk across the entire road. While some sections of the roadsides may remain unburnt for long periods of time, targeted weed control will be carried out on all segments.

The plan recommends regular monitoring of conservation condition using habitat hectare scores (DSE 2004b), species abundance (rather than key fire response species) and overall fuel hazard to assess the impact of prescribed burns on the fuel load and biodiversity and to determine the need for further burning.

Exotic grass can provide a greater fire threat than native species



Case study: NCCMA Box Ironbark Fire Management Strategy

Box-Ironbark ecosystems cover a large proportion of Victoria. They comprise approximately 250,000 hectares of predominantly dry sclerophyll eucalypt forest inland of the Great Dividing Range in northern Victoria.

The North Central CMA (NCCMA), as part of its *Regional catchment strategy and native vegetation plan*, identified the need to "Develop and implement appropriate fire management regimes to sustain ecological processes in key private land vegetation remnants…". NCCMA commissioned the Arthur Rylah Institute to implement this project.

Phase 1 of the project collated knowledge of fire responses (based upon floral vital attributes) and practices through review of literature and a science-based workshop (Tolsma, Cheal and Brown 2007a).

Phase 2 (management strategy) provided a decision framework to enable the requirement for ecological burning to be determined on a site-by-site basis (Tolsma, Cheal and Brown 2007b).

Fire needs

The authors noted that Box-Ironbark forests had not been shaped by regular fire to the extent that many other vegetation types had been, and that many plant species did not need fire to persist.

They concluded that most species should persist provided the inter-fire period allows all species to reach reproductive maturity (10-20 years), and will continue to be present even when the interval between fires exceeds 50 years.

Some flora and fauna species are particularly sensitive to fire, such as the ground-foraging Brown Treecreeper. It would be affected in the short-medium term after a fire by the reduction of litter. Daphne Heath may face local extinction if burnt twice within 5-10 years. However, occasional fire may benefit some shrub species and maintain vegetation complexity.

Despite fragmentation of the forest since European settlement, which may create a barrier to recolonisation after fire, the authors concluded that "fire remains a normal habitat process that in some instances may be necessary for the maintenance of species".

Fire management strategy

A decision framework was developed using the steps outlined in the *Guidelines for Ecological Burning* (DSE 2004a) as a basis. Key questions in the decision framework include:

- Is the time since fire outside the tolerable fire intervals?
- Will fauna species be negatively affected by fire?
- Can impact be acceptably reduced?
- Will habitat become unsuitable if not burnt?

The authors identify several barriers to effectively implementing the fire management strategy in the longer term. These are:

- A lack of fire-age data hinders the planning of broad-scale (mosaic) ecological burning on private land across the CMA.
- The relationships between fauna diversity and fire regimes are largely unknown in this area. To deal with this issue until more is known, this strategy uses vegetation composition and fire history to identify possible burns, with key fauna species playing a 'veto' role where necessary.
- The relatively infrequent need for fire (at around 50-year intervals) and discontinuity in private land ownership are likely to impose practical limits on what can be achieved.
- The lack of knowledge on the responses of specific Box-Ironbark flora and fauna species and communities to fire and patterns of burning that might maximise total biodiversity. However, the authors note that "appropriate use of fire in Box-Ironbark remnants, based on robust scientific data, should ensure that plant structural and floristic diversity can be maintained without disadvantaging fauna species in the long term".

7.2 Develop a sustainable fire management plan for a small reserve

Nillumbik Shire Council

South Gippsland Shire Council

Case study: Nillumbik Shire Council

Nillumbik Shire Council's draft Fire Management Plan for Professors Hill Reserve (obliqua pty ltd and Oates Environmental Consulting Pty Ltd 2010) is built upon Steps 1 to 6 outlined in this Guide.

Council biodiversity officer Brad Tadday explains. "This reserve is regionally important for conservation, particularly for its orchid flora, which is representative of what was once found over the whole region but is now confined to small remnant areas like this reserve. Two orchids found in the reserve are important at a state level. We want to make sure that we meet not only our obligations for community safety but also those for conservation."

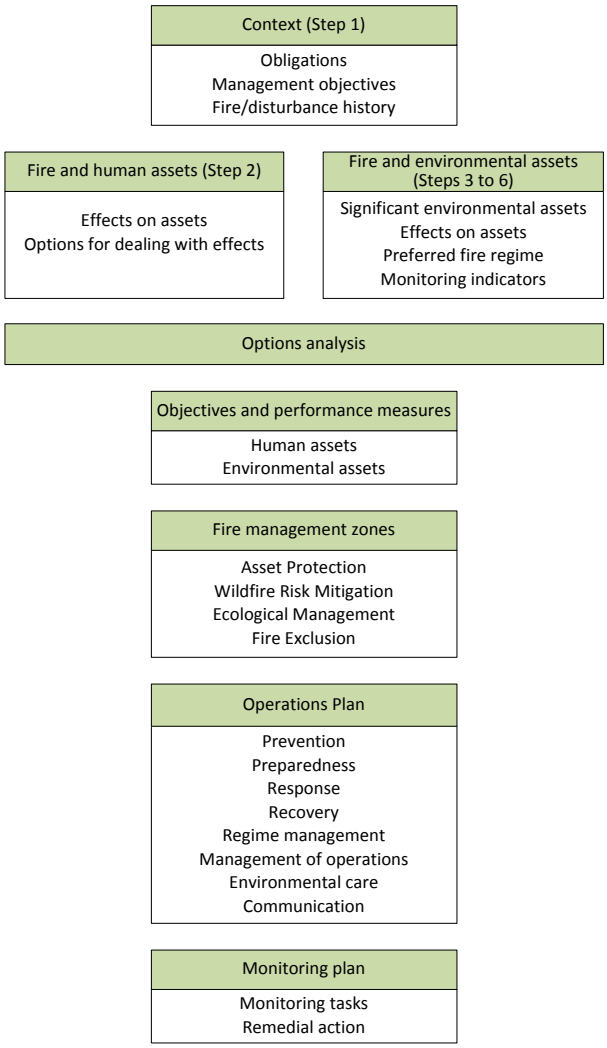
Council's draft plan was developed using the steps shown on the following page.

The plan identifies two options for protecting adjacent houses from the potential effects of a bushfire burning in the reserve, which has 'extreme' overall fuel hazard over much of its area.

Option 1 involves managing an asset protection zone for a depth of 60 metres along the northern boundary to an overall fuel hazard of 'moderate'. Option 2 reduces the depth of this asset protection zone to 25 metres, providing the remainder of the reserve can be managed to an overall fuel hazard of 'high'.

Overmature vegetation with high fuel hazard

Fire management planning process



To help Council to decide which option to select, the plan contains an options analysis. This assesses the environmental benefits and harm and community safety benefits associated with each option by comparing the proposed treatments with the preferred fire regime table developed in Step 6.

In summary, both options are considered to have potential to improve the environmental condition of the reserve as well as community safety by reducing dense stringybark saplings to environmentally preferred levels and reduction of over-mature shrubs.

Option 2 has the potential for lower environmental harm as there will be less need for soil disturbance on the steep slopes to create control lines for burning, although this impact can be managed through good design.

It is unclear if burning, which may be needed to manage surface fuel levels in the asset protection zone, will be beneficial or harmful to drought-affected orchids and other perennial plants. Therefore, the smaller asset protection zone is preferred until trials can establish the frequency of burning preferred by the orchids.

The plan uses the information developed in Steps 1 to 6 to set objectives and performance measures that are 'MAD' – measurable, achievable and desirable. It is proposed that progress towards and/or achievement of the objectives is audited every two years by an appropriately qualified external auditor.

Proposed objectives and performance measures

Objective	Measures	Target
Vegetation in the reserve is managed to ensure that flames or radiant heat in excess of 'low' do not affect adjacent houses.	Number of houses exposed to radiant heat in excess of 'low' from vegetation in the reserve.	Nil by 2012
Age classes of vegetation in the reserve outside of asset protection zones are within 25% of the ecologically preferred age class distribution for each EVC.	% variation between actual and target age classes.	25% by 2060
No flora or fauna species found in the reserve are lost through fire management.	Number of species compared with 2010 baseline.	No difference due to fire management
Soil loss and air and water pollution resulting from fire management meet best practice standards as set out in this fire management plan.	Number of operations compliant with best practice standards.	100% compliance for audited operations

The reserve has been divided into zones based upon the zoning system described in DSE's *Code of fire management for public land* (DSE 2006).

The operations plan sets out all activities proposed to be carried out by Council to achieve the objectives in each zone.

Examples from the proposed operations plan

	Proposed operations	Timing
Asset protection zone Target overall fuel hazard = moderate	Remove over-mature shrubs, retaining up to 5% in isolated clumps. Slash or cut regenerating shrubs so that elevated fuel does not exceed 'moderate'.	Pre summer
	Thin and/or burn stringybarks to reduce bark hazard to 'high' in accordance with draft prescriptions.	Winter
	Hand slash or patch burn small areas (10m by 10m) if needed to reduce surface and near-surface fuel to achieve overall fuel hazard target. Carry out burns in accordance with in draft prescriptions.	Late spring preferred
Survey key fire response species	Survey for key fire response species that indicate lack of fire using the method outlined for KFRS (refer to monitoring plan).	Spring prior to veg treatment
Trial burns	Burn trial areas (4x10m by 10m) in accordance with in draft prescriptions to determine vegetation and fuel response.	Autumn + spring
	Fence two burnt areas to exclude grazing and monitor trial as set out in monitoring plan.	ASAP
Ecological management zone (option 1 only)	Grassy Dry Forest: burn 3% every year in small patches (10m by 10m) following successful trials.	Autumn + spring
Community development	Partner with CFA to ensure that adjacent residents have prepared and are ready to implement their own fire management plans that identify triggers for leaving early on days of risky conditions. Fuel management to similar standards to that proposed for the reserve and improvement to buildings to help protect against ember attack.	ASAP
	Partner with CFA, DSE, Parks Victoria and other experts to conduct activities aimed at increasing the understanding of Council, service providers and the community about ecological fire needs.	2011

The operations plan sets out prescriptions for managing operations to help ensure objectives are achieved. For example:

- Prior to any works being carried out, an assessment for significant species is to be conducted and operations plans modified to protect these species where practical.
- All works will be supervised by a person or persons with skills in environmental management and assessment of overall fuel hazard.
- All burning will be supervised by a person with the appropriate CFA Complexity Rating (in this case CR2).
- All areas proposed for treatment and sensitive areas, including monitoring sites, slopes over 10 degrees and waterway buffers, will be marked and discussed on site with the appointed contractor.
- All treatment areas will be monitored to ensure compliance with prescriptions contained in this plan.

The operations plan also lists measures required to minimise environmental harm including those in the table (right). These are summarised from the 'ideal' fire regime.

Proposed environmental prescriptions

Asset	Management strategy
Significant species	Survey prior to treatment and adjust treatments if required.
Orchid and lily species	Ensure vegetation reduction operations do not have an impact on tubers in the soil.
Fauna habitat	Protect logs and trees with hollows from planned burns/bushfire Include larger trees in burns to encourage hollow formation Avoid damage to trees suffering from drought stress.
Soil/water quality	Minimise track construction or widening. Consider use of slashing and water to supplement the minimum mineral earth breaks required. Use leafblowers and rakes to construct mineral earth breaks. Avoid cutting into soil surface. Divert runoff from tracks/slopes away from gullies. Rehabilitate all temporary tracks as soon as practicable after use by blocking access, diverting drainage to minimise downhill water flow and creating conditions suitable for revegetation. Design thinning or burning operations to minimise disturbance to soil cover and to minimise overland flows of water, especially on slopes greater than 20 degrees. Blacking out of burns: minimise water use. Avoid using water to disturb soil surface. Design hose lays to minimise dragging of hose and damage to soil crust and vegetation.
Disease and weeds	Apply appropriate controls including vehicle washdowns and quarantine of infected areas.
Air quality	Plan all burns to minimise smoke impact on adjacent community. Burn small areas at a time, plan to burn with a wind direction that minimises smoke impact, and provide notifications to enable residents to avoid smoke.
Amenity and habitat	Maintain gates on all management roads.

The monitoring plan identifies tasks to be carried out before and after every operation to ensure that objectives are met. It also sets out action to be taken to address any issues identified through monitoring.

Case study: South Gippsland Shire Council

South Gippsland Shire Council recently took a similar approach to developing environmentally sensitive fire management plans.

One reserve presented particular challenges. Baths Road Reserve, Mirboo North, is surrounded by housing on all four sides. The 13-hectare reserve is part of a complex of native vegetation in the region, but is poorly connected to larger blocks. The overall fuel hazard was assessed as 'extreme' over most of the reserve, which supports two EVCs rated as 'Vulnerable' and two rated as 'Endangered' in the Strzelecki Ranges Bioregion.

Analysis of community safety needs indicated that a large proportion of the reserve would need be treated to reduce the potential for radiant heat to 'low'.

Feedback from community consultation did not support extensive clearance of vegetation. Concern was expressed about the loss of the character of the bushland as well as environmental values that this would cause. As a result, Council has limited mechanical clearance of understorey to a depth predicted to minimise flame impact on houses.

The remainder of the asset protection zones are scheduled for burning. These areas are close to the maximum tolerable fire interval for the EVCs and so the first burns on each site are expected to improve species diversity. Further consideration will be needed as to whether it is appropriate to re-burn these areas once they exceed the overall fuel hazard target.

CFA brigades have started implementing the burn plans for Baths Road Reserve. 'Candling' of the messmate trees was successfully carried out in one section during the winter of 2010.

Issue to be monitored	Location	Monitoring	
		Specifications	Timing
Need for fire	Whole reserve	Survey for key fire response species that indicate lack of fire using the method outlined below for KFRS.	asap
Appropriateness of burning drought-affected vegetation/significant sites	Trial plots to be selected	Monitor areas that are burnt and unburnt, fenced, and to compare the differences in vegetation structure, plant diversity using methods and assessment templates provided in the *Flora monitoring protocols for planned burning: a user's guide* (Cawson and Muir 2008).	Prior to burning Post burn (2 years) Post burn (5 years) Post burn (10 years)
Community safety outcomes	All sites	Visual inspection to determine overall fuel hazard, using the DSE *Overall Fuel Hazard Guide.*	Annually, preferably during spring
Biodiversity outcomes	All sites	Survey for threatened species.	Prior to treatments
	All ecological burn sites	Survey for fauna as set out in Treloar 2010.	As for plant surveys
		Carry out a fire severity assessment using the method and assessment template provided in the *Flora monitoring protocols for planned burning: a user's guide* (Cawson and Muir 2008, pp 71-74).	Post burn (2-6 weeks)
		Determine the change in presence and abundance of key fire response species and establish a permanent photo point after a burn using the methods and assessment template provided in the *Flora monitoring protocols for planned burning: a user's guide* (Cawson and Muir 2008, pp 52-54 and 59).	Prior to burning Post burn (2 years) Post burn (5 years) Post burn (10 years)
Erosion	All treatment sites	Visual inspection	Immediately after operation, then quarterly
Weeds		Visual inspection	Prior to operation
		Visual inspection	Immediately after operation, then quarterly
Pests/disease		Visual inspection for onset of disease	Annually
Relevance of plan		Review for completeness and relevance, based on monitoring data collected.	Annually/following any changes to state policy/if new house is built within 150 metres of the reserve.

7.3 Develop a sustainable fire management plan for a farm or lifestyle property

Case study: Trust for Nature covenanted property

Richard McCutcheon is a part-time farmer at Meerlieu on the Gippsland Lakes. His 600-acre property 'Woodfield' has eight bush blocks, the largest being 35 acres. Richard has covenanted his bushland with Trust for Nature and has fenced it to exclude grazing by cattle.

The largest bush block is located at the northern end of the property and has been assessed as unlikely to pose a risk to neighbouring houses in the event of fire. It supports Heathy Woodland (EVC 48, which is bioregionally of 'Least Concern') on the upper slopes. The lower slopes support Damp Sands Herb-rich Woodland (EVC 3, which is rated as 'Vulnerable'). There has been extensive dieback of Saw Banksia on the block, although this appears to be regenerating well. There is evidence of fire on this block in the past. Although the date of previous burning has not yet been determined, the vegetation appears to be in the 'mature' to 'old' phase.

A site assessment confirmed that there is an under-representation of younger and middle age-classes in the shrub and ground layer, although the overstorey dominated by Saw Banksia *Banksia serrata* seems to be regenerating adequately. Due to the long period since the last fire there has been a build-up of Saw Banksia leaf litter, resulting in a lower diversity of smaller shrubs and herbs in the ground layer. This is also accentuated by dense bracken in some areas and the ground layer often being dominated by Spiny Mat-rush *Lomandra longifolia*.

The fire management plan (obliqua pty ltd and Oates Environmental Consulting Pty Ltd 2009), which was prepared using Steps 1 to 6 outlined in this Guide, concluded that "patchy, low intensity burning in both the Damp Sands Herb-rich Woodland and Heathy Woodland EVCs could reduce the amount of leaf litter and promote the growth and diversity of sub-shrubs, herbs and native grasses. This could also benefit the control of weedy grasses that are in greater numbers around the edge of the block, adjacent to the pasture".

Richard is a staunch conservationist, coming from a family that has been active in conservation in Victoria for many years. However, he was reluctant to contemplate burning and as he saw it, "to interfere in the natural processes" and to "blacken that beautiful bush".

However, over the past few months his attitude has changed and he is now more receptive to the idea of trialling some small burns aimed at opening up the ground layer and regenerating other species.

"I have spent a lot of time walking in an area affected by the February 2009 bushfires at St Andrews. While this is a different forest type to the vegetation on my farm, I have seen the black landscape green up and countless different wildflowers and other small plants regenerate. I guess I now appreciate how well the bush does come back after fire."

The fire management plan for Richard's property proposes that 3-4 small patches (10 by 10m in size) be burnt under mild conditions (mid winter for this vegetation) and monitored before and after to determine the effect on vegetation using the table reproduced in Step 8 of this document as a guide.

The fire management plan identifies floral key fire response species to be monitored before and after burning. Species marked in blue are likely to be the best indicators for fire or disturbance that is too frequent. Species marked in yellow are likely to be the best indicators for fire or disturbance that is not frequent enough. Monitoring will record the presence or absence of these species on plots spaced at approximately 20-metre intervals over the block.

Species	EVC	Seed availability	Vegetative reproduction	Establishment conditions	Time to reproductive maturity	Extinction time	KFRS
Acacia genistifolia	3	S		I	5	50	2
Acacia longifolia s.l.	3/48	S	X	I	5	50	1
Acacia mearnsii	3	S	X	I	5	100	1
Acacia oxycedrus	48	S	Y	I	5	50	2
Banksia marginata	48	G	Y / X	T / I	10	100	1
Banksia serrata	3/48			I	5	100	1
Bossiaea cinerea	48	S	Y	I	5	20	2
Brachyloma daphnoides	48	G	W	T	10	100	1
Desmodium varians	3	S	W	I	2	20	2

Refer to Appendix 6-2 for the legend for floral vital attributes

EVC 3: Damp Sands Herb-rich Woodland

EVC 48: Heathy Woodland

7.4 Sustainable fire management on a residential property

CFA's *Fire ready kit* (CFA 2010a) provides guidance on managing vegetation around homes. It notes that:

"Managing the vegetation around your home has three main purposes:

- "To help you survive the passage of the fire front while sheltering inside your home.
- "To reduce the chance of direct flame contact and radiant heat igniting your home.
- "To help you protect your home from ember attack."

The amount of defendable space required to protect homes from radiant heat can be determined using the *Household bushfire self assessment tool* located in the kit or at www.cfa.vic.gov.au.

The kit provides suggestions for maintaining the defendable space in a low-fuel state, including:

Inner (10 metre) zone around house	Shrubs must be less than one metre Do not have shrubs next to or under windows Grass should be less than 10 centimetres high Do not have tree branches in the 10-metre space
Outer zone (to depth of required defendable space, which may be up to 100 metres)	Incorporate low fuel areas such as driveways, lawns or dams Take out half the shrubs Keep grass short Prune shrubs so that their tops are well away from the lower branches of trees Prune the lower branches of shrubs to separate the foliage from the surface fuels underneath Remove loose bark from trees Remove weeds Use non-flammable mulch or keep it damp

The kit also provides suggestions on protecting environmental assets that may be located within the defendable space:

- When planning your fuel management, protect streamside vegetation and wetlands to help prevent sedimentation and protect habitat. These sites may be damp and less fire-prone and may not present a hazard.
- Weeds can contribute significantly to bushfire risk. Give priority to removing and controlling them. Your council can help you identify weeds in your local area and provide ideas on how to remove them.

Use the table provided in Step 5 of this Guide to identify other ways of protecting environmental assets in the defendable space.

If environmental assets threaten the safety of the house, consider ways of compensating for this. For example, it may be practical to reduce the fuel over a larger area or to a higher standard.

CFA's *Household bushfire self-assessment tool* identifies the amount of vegetation management required based upon a reasonably low standard of building construction. Look at ways in which the bushfire attack level rating of the building could be improved by considering performance measures set out in the *Australian Standard AS 3959: 2009* and *A guide to retrofit your home for better protection from a bushfire* (CFA and Building Commission 2010). This may enable the recommended levels of vegetation management to be reduced or modified.

7.5 Plan land use to minimise the impact of community safety proposals on the environment

Bushfire safety requirements such as the Wildfire Management Overlay (WMO) or the Bushfire-prone Overlay (BPO) proposed by the Victorian Bushfires Royal Commission may appear to be incompatible with biodiversity conservation obligations such as planning scheme overlays or EPBC Act permit requirements.

A pilot project undertaken by CFA and DSE to develop decision-making tools for planners provides an example of how such apparent conflicts can be addressed.

Gooding (2008) reported that although evaluation of a project indicates that the "decision making tools developed for application in the regulatory framework have some value, the principal change agent was the closer working relationship between the regulatory, land and emergency management agencies".

He identified that "a significant barrier to achieving the project aim is the extent to which the broader community understands the basis of bushfire risk and conservation management" and that "to achieve a sustainable and comprehensive change to a community's capacity to address bushfire risk, stakeholder agencies must have:

- "a working knowledge of the policy objectives, tools and drivers of their partner organisations
- "shared understanding of effective community engagement
- "acceptance of the need to achieve multiple land management objectives
- "combined advocacy for solutions."

Planning controls aimed at environmental protection include:

- Section 52:17 of the State Planning Policy Framework
- Vegetation Protection Overlay (VPO)
- Environmental Significance Overlay (ESO)
- Significant Landscape Overlay (SLO)
- Erosion Management Overlay (EMO)
- Salinity Management Overlay (SMO).

CFA in partnership with DSE and four councils developed draft guidelines to assist planning applicants, landowners and local councils wanting to address the objectives of both the Wildfire Management Overlay and planning controls aimed at protecting native vegetation (CFA and DSE 2008).

The guidelines are based upon the 'Three Step Approach' for managing native vegetation (DNRE 2002a) and are summarised in the following table.

This table shows how to design a development that could meet the permit requirements for a site where native vegetation may need to be removed and the Wildfire Management Overlay applies.

Designing a development to meet site conditions

STEP	Native vegetation framework	Wildfire Management Overlay	Site response
1	AVOID VEGETATION REMOVAL Examine the siting options to completely avoid vegetation removal	AVOID BUSHFIRE IMPACT ON DWELLING Examine the options to locate the development at a site where the bushfire intensity will be lowest	DESIGN SITING
2	MINIMISE VEGETATION REMOVAL Determine the land management and development design options to minimise any unavoidable losses at the site	MINIMISE BUSHFIRE IMPACT ON DWELLING Determine the land management, infrastructure, and building design options to reduce the impact of bushfire on a dwelling	DESIGN RESPONSE
3	OFFSET VEGETATION IMPACT Determine the offsets for the permitted loss in accordance with DSE Practice Notes (e.g. DSE 2008b)	MITIGATE BUSHFIRE RISK Determine development design detail in accordance with the WMO Applicant's Kit (CFA 2010b)	DESIGN DETAIL

Model for selecting the site of a house (or fire management works)

The following example provides a useful model for determining the most appropriate house site, after considering conservation and safety priorities. This approach could also be used to determine the preferred location of a fire management treatment for a fire management plan.

This example identifies the fire risk and the conservation status in 50 metre by 50 metre grid squares within 100 metres of three proposed house sites.

These guidelines use the WMO vegetation category to describe fire risk. Other risk measures could also be considered including the bushfire attack level from the *Australian Standard AS3959:2009*, overall fuel hazard, or expected fire intensity under specified conditions.

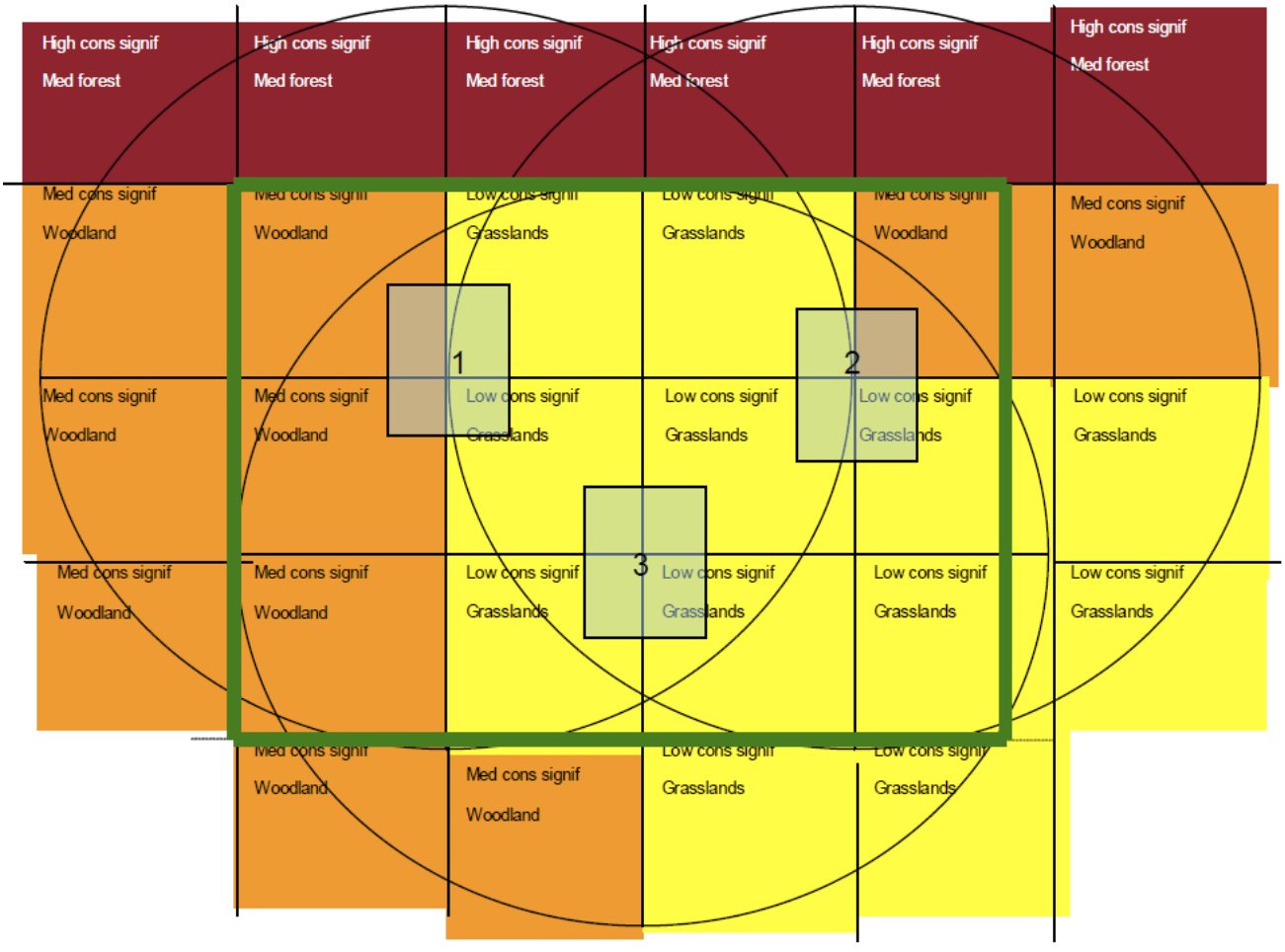
The guidelines suggest that conservation status be based upon the habitat hectare method, which is the DSE-recognised method for assessing native vegetation in accordance with the *Native vegetation management framework* (DNRE 2002a).

The habitat hectare score measures the quality and quantity of native vegetation relative to a 'benchmark' for that EVC.

Other measures of conservation status may also be worth considering, including the bioregional conservation status of the EVC, the presence or absence of significant species or habitat, or the degree of disturbance.

In this example, the preferred location for a house site is site three, which will be exposed to the lowest bushfire intensity and where the vegetation affected is of the lowest conservation significance.

Red	High conservation significance
Orange	Moderate conservation significance
Yellow	Low conservation significance
	Property boundary



Case study: Property bushfire preparation and native vegetation management

Reproduced from CFA (2005c)

Summary

It is possible to prepare a property for bushfire and look after native vegetation.

With support from the Shire of Yarra Ranges and CFA, a Yarra Junction landholder has been able to plan both property bushfire preparation and native vegetation management.

The challenges

To get a planning permit to build a house, the owner had to demonstrate how their proposal would comply with bushfire safety and native vegetation legislation.

With a passion for native plants and animals, this landholder wanted to manage bushfire risk in a way that would limit impacts on the property's native vegetation.

Choosing good ways to do this requires knowledge of bushfire preparedness and native vegetation.

The approach

Before developing a planning permit application, the owner met on site with CFA and Shire of Yarra Ranges staff.

The meeting allowed everyone to discuss both bushfire preparedness and native vegetation issues, and to identify possible design solutions.

"Design solutions quickly suggest themselves when bushfire safety and native vegetation personnel, and the owner get together on site"
– Shire of Yarra Ranges Environment Officer.

The landholder was then able to develop a proposal to reconcile bushfire preparation and conservation objectives.

The most important step was to choose a house site that would reduce both bushfire risks and impacts on native vegetation.

For a number of years the front of the block had been regularly slashed. This had kept fuel hazards relatively low and had resulted in a high diversity of native plants.

On this particular site, a careful slashing regime and selective removal of a few shrubs will provide a fuel modified area and keep a high level of ground plant diversity. (NB. Appropriate vegetation management techniques are generally site specific).

Locating the house at the front of the block will also avoid a long driveway. This will provide good access for emergency vehicles and reduce the amount of vegetation removal.

The proposed house is based on Australian Standard 3959 Building in Bushfire Prone Areas. This includes consideration of windows and cladding. Careful house design also means that most of the mature trees can be kept.

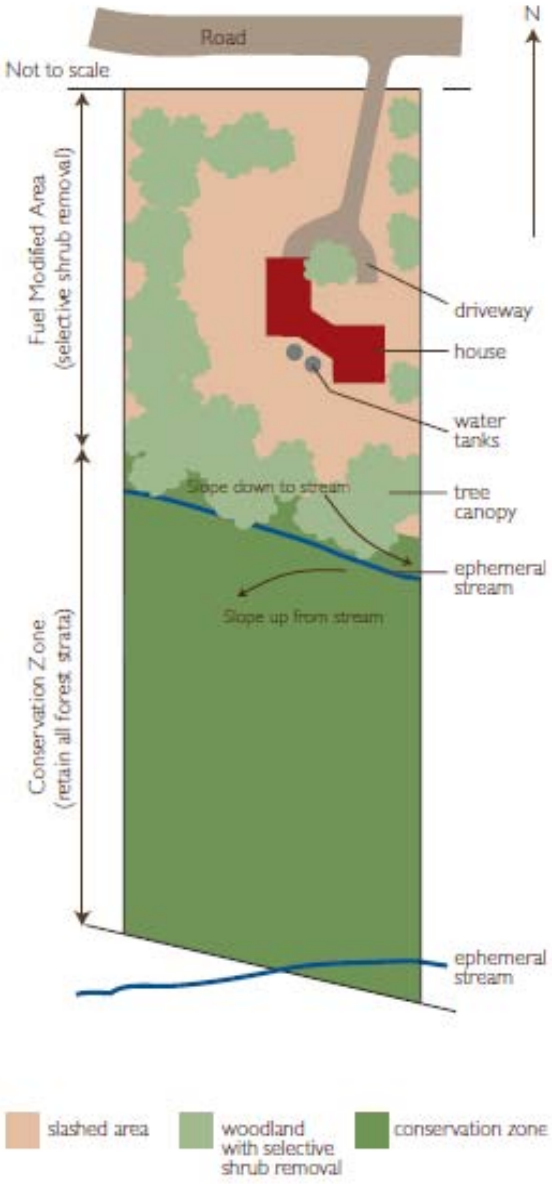
All this technical information was documented in a Property Management Plan that was presented to council in support of the owner's planning permit application.

Property Management Plans (PMP)

A PMP covers all of the land and shows existing and proposed conditions. The plan documents the Native Vegetation Framework "three step approach" to the design. (See more information)

A PMP documents the following:

- Location of vegetation types and quality
- Lists of weeds and native species
- Location of defendable space (fuel modified area) and it's maintenance plan
- Survey of existing and proposed structures
- Areas of vegetation to be protected and restored, to offset removed vegetation
- Biodiversity threat management plan



7.6 Planning and implementing burning operations for environmental outcomes

Many land managers, including agencies, request CFA to plan and conduct burns for them. CFA provides guidance to CFA members on planning and implementing burns in the following Chief Officer's Standard Operating Procedures (CFA 2009a, CFA 2009b):

- SOP 9.39: Procedures for planning a prescribed burn or burn off
- SOP 9.40: Procedures for conducting a prescribed burn or burn off

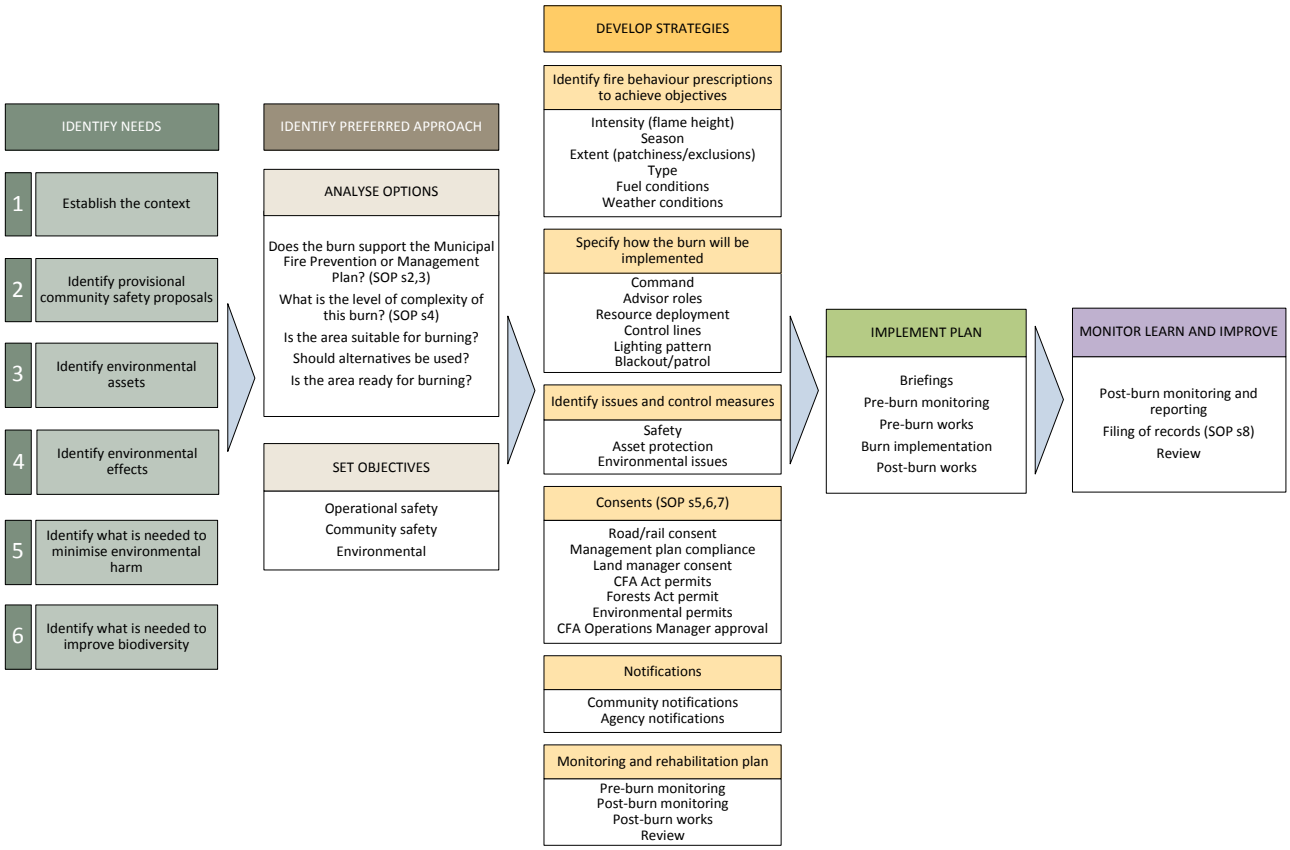
As outlined in the introduction to this Guide, these SOPs provide broad direction on environmental management requirements.

This section of the Guide provides more detailed guidance on how to identify and address environmental issues when planning and implementing a burn based upon these SOPs.

This process is built upon Steps 1 to 6 already outlined. Steps 1 to 6 would normally be completed as part of a fire management plan, which might include proposals for several burn units.

Planning and implementing a burn is a specialist activity and should only be carried out by those competent to do so.

Summary of prescribed burn planning process (adapted from SOP 9.39)



Analyse options

The options analysis step requires consideration of whether areas are generally suitable for burning and whether they are now ready to burn. Check the following steps in this Guide to assist you with analysis of options.

Some questions to consider	Comments	For further information
Is fire appropriate to this site?	Fire will only be suitable for some EVCs.	Step 6.2 and 6.7
Should alternatives to burning be used?	Alternatives (such as hand or mechanical clearing) or a staged approach to burning should be considered if high intensity fire is likely, or if fire is likely to affect environmental assets in other ways (e.g. vegetation is suffering from drought and may not recover from fire).	Step 5
Is the area ready for burning from an environmental viewpoint?	If the area is to be burnt for environmental outcomes, it will only be ready if it meets or exceeds the fire frequency requirements for the area or a specific environmental asset. If the area is to be burnt for protection outcomes and does not meet the fire frequency requirements, consider alternatives to burning or a patchy burn.	Steps 6.4-6.5

Set objectives for the burn

All burns should have at least one environmental objective in addition to community safety objectives.

Each objective should be 'MAD' (measurable, achievable and desirable). They should be based upon consideration of Step 1 (specifically obligations and management objectives) and Steps 3 to 6 (significant assets, effects and preferred fire regime). Examples of environmental objectives include the following:

- To avoid impact on the environment from burning including loss of hollow trees and large logs and pollution of Wombat Creek.
- Scorch no more than 30 per cent of the canopy.
- Smoke impact on the adjacent community is limited to a four-hour period.
- To avoid loss of the vulnerable Striped Legless Lizards due to burning.
- To convert 50 per cent of the 'mature' growth stage on the burn site to 'young' to create conditions suitable for regeneration of the rare orchids (include names).
- To kill 90 per cent of all woody weeds on the burn site and stimulate regeneration of weed seeds for herbicide treatment.

Identify prescriptions to achieve objectives

- Using the ideal fire regime for the burn area (Step 5 and Step 6.6), identify requirements for fire intensity, season, extent and fire type that will achieve the environmental objectives and fit the fuel and weather conditions.
- Use this information to specify the weather and the fuel conditions needed. This is a specialist task. Further information on this step can be obtained from the latest version of DSE's *Prescribed Burning Manual* (DSE 2008a).

Prescriptions for the examples given above could include:

To avoid impact on the environment from burning including loss of hollow trees and large logs	Extent: exclude these areas Intensity: low
Scorch no more than 30% of the canopy	Type: avoid crown fire Intensity: low
Smoke impact on the adjacent community is limited to a four-hour period	Weather: select wind direction Extent: burn size
To avoid loss of the vulnerable Striped Legless Lizards due to burning	Season: burn late summer (when lizards can escape into soil cracks)
To convert 50% of the 'mature' growth stage on the burn site to 'young' to create conditions suitable for regeneration of the rare orchids	Intensity: low, to create patchy fire Season: spring (damp soil to help patchy fire, follow-up rain for regeneration)
To kill 90% of all woody weeds on the burn site and stimulate regeneration of weed seeds for herbicide treatment	Intensity: higher intensity (to kill woody weeds and regenerate hard-coated seed)

Specify how the burn will be implemented

The following issues can have a significant impact on achievement of environmental objectives.

Command

Good leadership may be needed to ensure that all prescriptions, including environmental ones, are understood and carried out.

- Plan to brief the burn controller on environmental issues and how they can be managed.
- Include this information in the briefings of all personnel involved in the burn and pre and post-burn works.

Environmental advisor role

Environmental issues and precautions should be included in the burn plan. However, consideration should be given to having an environmental advisor on-site during the burn to:

- provide specialist input into the crew briefing
- oversee site preparation for protection of environmental assets (e.g. raking around habitat trees)
- provide advice on options for protecting environmental assets should it be necessary to change the plan during implementation
- carry out post-burn environmental monitoring (in addition to pre-burn monitoring).

Resource deployment

Allocate adequate resources to any specialist tasks, such as monitoring and protecting hollow trees that are to be excluded from the burn. Good site preparation is critical.

Control lines

Design and location of control lines is critical not only to containing the burn but also minimising environmental harm.

- Using information in Step 6, design control lines that will minimise environmental harm.
- Plan for rehabilitation of all control lines not required for management purposes as soon as possible after the burn has been completed.

Lighting pattern

Design and location of the lighting pattern for the burn is critical to fire intensity, community safety and environmental objectives.

Plan for lighting to achieve the planned flame height/intensity set out in the prescriptions for the burn.

Blackout/patrol

Tactics used in blacking out can have a significant effect on the environment.

- Using Step 5 as a guide, plan to use tactics for blacking out/patrol that minimise water use, soil disturbance and loss of significant habitat such as logs and mature and hollow trees.

Identify issues and control measures

This section of the burn plan template can be used to itemise specific environmental requirements not included under 'prescriptions'.

Consent

Consent may be required for environmental issues.

- Consult early in the planning process with regulators to determine possible issues and how they may be resolved.
- Obtain all necessary permits before seeking approval of the burn plan.
- Notify neighbours, police, CFA, council and DSE before the burn.

Issue	Regulatory instruments	Regulator
Biodiversity	EPBC Act FFG Act	DSEWPC DSE
Waterways	CaLP Act	CMA
Air quality	EP Act	EPA
Biodiversity, air quality	Planning scheme /local Laws	Council

Monitoring and rehabilitation plan

Monitoring is required to:

Support decision-making	to assess if it is 'time' to burn to find the range of conditions that meet objectives to determine the appropriate prescriptions to determine if further research is required.
Assess if further action is needed	for example, is erosion or weed control needed?
Assess if objectives of the burn have been achieved	

Monitoring of planned burns should be well targeted, necessary and simple to implement.

For further information on monitoring refer to Step 8 'Monitoring, learning and reviewing'.

Case study: South Gippsland burn targets stringybarks first

Several brigades helped Koonwarra Fire Brigade to reduce the bark hazard on stringybark trees located around the perimeter of a block planned for burning in the Koonwarra Bushland Reserve, which adjoins the township.

Operations officer Simon Bloink and the environmental advisors who prepared the fire management plan for the reserve provided a briefing to brigades, which included advice on minimising environmental damage by keeping flames out of the tree canopies.

"We would have liked to have burnt the whole block in one operation," Bloink said, "but by candling the stringybarks first, next time we burn the block the fire intensity should be much lower as the bark hazard will be less. This will make it easier and safer to burn this block. And there is also likely to be less damage to the tree crowns."

Case study: Fire as a management tool requires careful consideration

Reproduced with permission of Nillumbik Shire Council

Senior environmental works officer Brad Tadday, of Nillumbik Shire Council, recounts the preparation and follow-up work required to ensure best management practices in the implementation of a prescribed burn.

"The prescribed burn at Yirrip Reserve, Kangaroo Ground, was recommended in the reserve's fire management plan to reduce fuel throughout the asset protection zone adjacent to private properties.

"Although fire has naturally been a significant influence on Australian ecosystems, the use of fire as a management tool needs to be carefully considered on all levels. While fulfilling Council's responsibility towards community safety, it was also necessary to ensure that the burn did not detrimentally impact on the significant values of the natural environment.

"Expert advice has informed us that the main fuel reduction benefit from a prescribed burn will be on reducing the bark fuel; all other fuels are likely to increase to the same pre-fire level within five years.

While burning every five years is impractical on a resource level, it will also cause a loss of species and dramatic ecosystem change. Woody weeds may be stimulated by fire thus adding to management issues. Rabbits will be attracted to new regrowth and may destroy any ecological benefit from the fire by demolishing seedlings.

"Depending on the severity of the fire and site characteristics, erosion may become an issue if not managed closely. Habitat may also be lost if hollow trees and logs are caught alight.

"To monitor the achievement of our objectives at Yirrip Reserve, eight monitoring plots and 24 photo points were set up throughout the proposed burn site. The control line was constructed as sensitively as possible. Instead of a rake-hoe line scraped to mineral earth, the line was brush-cut and raked clear of sticks and leaves. Environmental assets such as sensitive trees and candlebark, ironbark, and habitat trees, as well as hollow logs, were also protected in a similar manner.

"The timing of a prescribed burn is crucial to the result. Only a small window of opportunity was open for our burn at Yirrip between the end of fire season and the emergence of significant orchids. The burn was delayed a week to wait for local vineyards to harvest their grapes and avoid smoke taint in their wine. The week after that was too wet to burn. Then finally there was the perfect day, just before it was too late for this season.

"The burn progressed beautifully without incident, running up the bark of the stringybarks to reduce the bark fuel. None of the habitat trees were lost to fire and only two hollow logs were reduced to ashes. A mosaic of unburnt patches throughout the site provided a refuge for small animals and insects. The site was blacked out then monitored for 48 hours before the rain finally set in.

"It doesn't stop here though; ongoing works include after-fire photo points and control line rehabilitation. A thorough rabbit control program in also underway to ensure the regenerating plants, in particular the rare orchids, are not grazed out. Seasonal data collection of the monitoring plots will examine the ecological effects of the fire over time so we can learn as much as possible from this experience and adapt our management practices for further improvement.

"With the help of local experts and consultants on fire and ecology, and our environmental contractors, we are gradually finding the way to meet our fire safety obligations while maintaining the balance of ecological integrity."

7.7 Helping others to practice sustainable fire management

CFA learning project

Hotspots program (NSW NCC)

Evaluation of fire regimes on private land

CFA personnel involved in vegetation management all have a role to play in helping others to improve their fire management practices. An important component of this is helping others to carry out fire management in an environmentally responsible way.

Changing any behaviour involves addressing and overcoming some significant barriers such as knowledge, attitude, cost, resources and time.

These case studies provide examples of the way different organisations have started to tackle this challenge.

Case study: Learning about ecologically responsible fire management

The Ecologically Responsible Roadside Management Project was launched at Hawkesdale on 26 November 2009. It is a joint project between the Country Fire Authority (CFA), Moyne Shire Council, Department of Sustainability and Environment, Southern Grampians Shire, VicRoads and the community. The project is funded by the World Wildlife Fund-Australia from a Threatened Species Network Community Grant.

The project aims to recognise, encourage and support volunteer CFA brigades and landholders who conduct ecologically responsible works for fire protection on roadsides. These works include burning that conserves native grassland communities and is done with an appropriate frequency and in the right season.

In south-west Victoria, local volunteer CFA brigades burn more than 2600 km of roadsides each year in accordance with the Municipal Fire Management Plan. Fuel reduction burning in roadsides can increase community safety. If it is done in an ecologically responsible manner then it can also protect important grassland remnants such as the nationally listed Natural Temperate Grassland of the Victorian Volcanic Plain and a wide range of Australian and Victorian threatened species. As highlighted in the case study 'Municipal fire management in protected grasslands' (Step 7.1), maintenance of native grasslands can result in lower fuel loads and fire intensity, making roadsides safer to work from.

This project builds on earlier initiatives funded through the Grassroots program. These grants funded the installation of large pictorial signs in key public locations, including on the side of fire station sheds (Shelford, Wallinduc and Snake Valley brigades). These signs were designed to highlight to the community and brigade members the value of native grasslands and the importance of regular burning regimes.

This project has resulted in the development of additional interpretive materials, such as banners and brochures. CFA is also using the materials at agricultural field days and other events and venues. Most importantly, vegetation management facilitators with CFA, are presenting information to landholders at a series of meetings.

Case study: Hotspots fire program (NSW Nature Conservation Council)

The 'Hotspots' program aims to help communities to develop and implement science-based fire management plans for the dual objectives of fire safety and biodiversity conservation, through facilitated workshops.

The program works at a range of scales from the property through to the regional level and includes facilitating prescribed burning on broad-acre private lands.

Program elements include:

- community consultation on fire management issues to determine local needs
- learning opportunities (e.g. field trips with experts)
- development of science-based resources to guide environmentally responsible fire management planning and implementation
- facilitated workshops with individual property owners, communities or other bodies to assist them to develop and implement fire management plans
- ongoing support and facilitating linkages to help participants to implement plans.

This program has been operating successfully in NSW for more than five years. Funded by the New South Wales Environmental Trust, the program is delivered by the Nature Conservation Council of NSW. Regional partners include the NSW Rural Fire Service, NSW Department of Environment and Climate Change, the catchment management authorities, and the NSW Farmers Association.

A video outlining program achievements and extensive resource materials are located on the NCC website (www.nccnsw.org.au).

The video is also available on the CFA intranet under Community Safety > Environment.

Case study: Fire regimes on private conservation lands

Lucy Halliday carried out a study (Halliday 2010) that may be of benefit in designing approaches to influencing landholders to carry out ecologically appropriate fire management works, including regime management.

Halliday investigated issues surrounding the management and maintenance of fire regimes on private conservation lands in north-east NSW and south-east Queensland.

These areas have benefited from two programs aimed at introducing ecologically sustainable fire regimes on private property through use of science and community engagement: Hotspots (NSW) and the Fire and Biodiversity program (South-east Queensland Fire and Biodiversity Consortium).

Despite the significant effects that fire can have on biodiversity as well as life and property values, fire was not a key management priority among most landholders.

Halliday found that while private conservation landholders acknowledged the risk and responsibilities of fire management on their lands, and did undertake actions to reduce fuel hazards and prepare for bushfire events on their land, they directed far less effort towards fire management than other conservation management actions.

Despite the "established role and benefits of fire to many ecosystems in the region", Halliday found that:

- landholder attitudes towards, and understanding of, the ecological role of fire was generally poor
- few private conservation landholders were aware of ecologically appropriate fire regimes for the vegetation types on their property
- few undertook fire management actions to achieve ecological outcomes, despite formally designating their lands for nature conservation
- fire is occurring at intervals outside the recommended range across all vegetation classes, which is threatening the integrity of these ecosystems.

Halliday identified barriers to implementation of fire management as:

- significant site-specific obstacles
- lack of knowledge and experience with fire management
- legal and containment concerns.

Halliday's research highlights the need for property-specific fire management planning across all private conservation lands to:

- enable landholders to integrate ecological fire requirements into biodiversity management
- prioritise actions that aim to improve conservation outcomes while safeguarding life and property.

Case study: Fire regimes on private conservation lands (continued)

This report includes the following additional recommendations:

- The continuation of community fire management planning workshops, and cooperation between fire and land management agencies, to build the capacity of landholders to put their plans into practice.
- Provision of incentives to encourage collaborative fire planning and implementation projects to achieve outcomes at a larger scale.
- Implementation of an appropriate system for recording fire history.

7.8 Assessing the level of risk to environmental assets

Risk from bushfire or planned fire

Risk from other fire management works

Risk can be defined as a combination of likelihood and consequences. Environmental risks can be grouped into two categories: risk to the environment and risk to an organisation from environment-related activities (Standards Australia/Standards New Zealand, 2006).

Risk assessment can be used to quantify:

- the priority for action to reduce the risk
- whether specific treatments will be effective in reducing risk.

Risk from bushfire or planned fire to environmental assets

The *Victorian Fire Risk Register* (*VFRR) Reference Guide* (CFA 2010c) outlines a process for assessing the risk to environmental assets from bushfire or planned fire that is outside the asset's preferred fire regime (or tolerable fire interval as described in Step 6 of this Guide). It is summarised in the following pages.

Introduced Cinnamon fungus can severely affect Austral Grass Trees

Likelihood of fire affecting environmental assets

The *VFRR Reference Guide* (CFA 2010c) bases the likelihood of fire on two factors:

- Do fires occur frequently?
- If a fire occurs, is it expected to spread and reach environmental assets?

Likelihood is categorised as unlikely, possible, likely or almost certain as shown in the following table.

	Fires are expected to spread and reach assets	Fires are not expected to spread and reach assets
Fires occur frequently	Almost certain	Possible
Fires occur infrequently	Likely	Unlikely

Consequences of fire affecting environmental assets

Consequence ratings for an environmental asset can be determined by considering the vulnerability of the asset and the potential impact of the effects of a bushfire or planned fire.

Vulnerability of an environmental asset

The vulnerability of an environmental asset to fire is based on its conservation status and the geographic extent or range of the asset.

Conservation status (endangered, vulnerable or locally important) is used to provide an indication of the relative importance of an environmental asset.

Geographic extent, or distribution, is used to provide an indication of the uniqueness or rarity of a particular environmental asset.

The *VFRR Reference Guide* (CFA 2010c) proposes that the geographic extent of environmental assets be determined using the following table.

Category	Description
Highly Restricted	The species or community is found in one municipal area.
Restricted	The species or community is found in two to four municipal areas.
Widespread	The species or community is found in five or more Municipal areas.

The following table provides a means of determining the vulnerability of an environmental asset to bushfire or planned fire.

	Conservation status		
Geographic extent	**Locally important**	**Vulnerable**	**Endangered**
Highly Restricted	Moderate	High	Very High
Restricted	Low	Moderate	High
Widespread	Low	Low	Moderate

Potential impact of fire

The potential impact of fire can be divided into three categories:

- Exclude fire – Fire should be excluded or conditions applied to significantly restrict the use of fire in the area such as "no burning within 100m of stream" or "no burning in spring or summer". Fire outside the tolerable fire interval (Step 6 of this Guide) for species or communities would also fall into this category.
- Restrict fire – Standard restrictions for fire may be required, such as "no more fire than once every five years".
- No conditions – It is likely that this outcome will only be applied in severely degraded native vegetation.

Determining consequence

There are four categories for consequence: minor, moderate, major and catastrophic. The following table can be used to determine consequence ratings for environmental assets.

	Vulnerability			
Potential impact of fire	**Low**	**Moderate**	**High**	**Very High**
Exclude fire	Moderate	Major	Major	Catastrophic
Restrict fire	Minor	Moderate	Moderate	Major
No conditions	Minor	Minor	Minor	Moderate

Determining risk to environmental assets

The VFRR tool calculates risk from likelihood and consequences using the following table.

	Consequences			
Likelihood of fire	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	High	Very High	Extreme	Extreme
Likely	Medium	High	Very High	Extreme
Possible	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High

Risk from other fire management works to environmental assets

The approach taken in the *VFRR Reference Guide* (CFA 2010) for assessing the risk to environmental assets from bushfire or planned fire can also be used to assess the environmental consequences of other fire management works, such as the construction of firebreaks.

Consequences of other fire management works affecting environmental assets

Consequence ratings for each environmental asset can be determined by considering the vulnerability of the asset (refer above) and the likely impact of those works.

Likely impact of fire management works

The likely impact of fire management works (such as firebreak construction) can be divided into three categories:

- exclude works
- resite or restrict works
- standard/no conditions.

The following table can be used to help determine the appropriate category.

Likely impact of fire management works	Standard/no conditions	Resite or restrict works	Exclude works
Obligations/ compliance	Minor non-compliance with Flora and Fauna Guarantee, Catchment and Land Protection, or Environment Protection Acts.	Moderate non-compliance with Flora and Fauna Guarantee, Catchment and Land Protection, or Environment Protection Acts.	Significant impact to matters protected under the Environment Protection and Biodiversity Conservation and Flora and Fauna Guarantee Acts. Major non-compliance with Catchment and Land Protection Act (e.g. significant soil erosion). Major non-compliance with Environment Protection Act (significant water quality and/or air quality breach).
Relationships/ reputation	Minor deterioration of stakeholder relationships	Moderate deterioration of stakeholder relationships.	Substantial deterioration of stakeholder relationships.
Environmental extent of impact	Substantial damage to small area or number of individuals/ assets.	Substantial damage to moderate area or number of individuals/assets.	Substantial damage to large area or number of individuals/assets.
Environmental duration of impact	< 1 year	1-3 years	> 3 years

Adapted from DSE (2010d)

Determining consequence

There are four categories for consequence: minor, moderate, major and catastrophic. The following table can be used to determine consequence ratings for environmental assets.

	Vulnerability			
Likely impact of fire mgmnt. works	**Low**	**Moderate**	**High**	**Very High**
Exclude works	Moderate	Major	Major	Catastrophic
Resite or restrict works	Minor	Moderate	Moderate	Major
Standard/no conditions	Minor	Minor	Minor	Moderate

Adapted from CFA (2010c)

Case study: Risk of inappropriate fire regime on the Eltham Copper Butterfly

The Eltham Copper butterfly is listed as threatened under the Victorian Flora and Fauna Guarantee Act (1988) and is considered endangered. It is found in three regions: north-western Victoria (Kiata/Salisbury), central Victoria (Castlemaine/Bendigo) and outer north-eastern Melbourne (Eltham and Greensborough).

In Eltham, most of the colonies occur in dry open *Eucalyptus* forest with an open, grassy understorey containing scattered patches of Sweet Bursaria and other shrubs.

There is an intricate relationship between the caterpillar of the butterfly, soil-nesting ants of the genus *Notoncus,* which tend the caterpillars, and the Sweet Bursaria, which the caterpillars feed on. All three factors are required for the species to survive.

A draft fire regime has been prepared for the Eltham Copper Butterfly reserves in Eltham (obliqua pty ltd, Oates Environmental Consulting Pty Ltd, INVERT-ECO, and Ecoplan Australia, 2011). It confirms that particular care is needed with the frequency, extent, season, intensity and type of fire management to reduce fuel in butterfly habitat and to improve habitat for the butterfly, which requires open flight paths and juvenile Bursaria foliage.

This plan assessed the risk of inappropriate fire management to the Eltham Copper Butterfly using the principles of the *VFRR Reference Guide* (CFA 2010c).

The vulnerability of the Eltham Copper Butterfly to inappropriate fire regimes was assessed as follows:

- The conservation status is 'Endangered'.
- While the butterfly is found in more than one municipality, it has been assessed as 'Highly Restricted' (rather than 'Restricted' as suggested in the *VFRR Reference Guide*) as the Eltham populations are very small and are geographically isolated to the individual reserves they are found in.

Using the following table, the vulnerability of the Eltham Copper Butterfly to inappropriate fire or fire management can be rated as 'Very High'.

	Conservation Status		
Geographic extent	**Locally Important**	**Vulnerable**	**Endangered**
Highly restricted	Moderate	High	Very High
Restricted	Low	Moderate	High
Widespread	Low	Low	Moderate

The likely impact of fire or fire management was assigned the highest impact category. This category (fire exclusion) was expanded from the advice provided in the *VFRR Reference Guide* to include situations where there are very specialised and restrictive fire regime requirements, as required by the Eltham Copper Butterfly.

Based on a vulnerability of 'Very High' and the highest impact rating, the consequences of inappropriate fire or fire management (such as allowing the shrub canopy closure to continue, or over-clearing of butterfly habitat for community safety reasons) have been assessed as 'Catastrophic'.

	Vulnerability			
Likely impact of fire/ fire mgmnt.	**Low**	**Moderate**	**High**	**Very High**
Fire/fire mgt exclusion or restrictive conditions required	Moderate	Major	Major	Catastrophic
Conditions required e.g. fire frequency requirements	Minor	Moderate	Moderate	Major
No conditions	Minor	Minor	Minor	Moderate

Based on the following table, and the possibility that an inappropriate fire regime may be required and consequences of 'Catastrophic' (as outlined above), this plan assesses the risk to the Eltham Copper Butterfly from inappropriate fire or fire management as 'Very High'.

	Consequences			
Likelihood of inappropriate fire/fire mgmnt.	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	High	Very High	Extreme	Extreme
Likely	Medium	High	Very High	Extreme
Possible	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High

Case study: Risk of inappropriate fire management on soil stability

While all potential threats to environmental assets need to be managed through appropriate practice, soil stability needs particular attention.

The Fire Management Plan prepared for South Gippsland Shire Council's Pioneer Reserve at Kongwak (obliqua pty ltd and Oates Environmental Consulting Pty Ltd 2011) notes that because of the "steep slopes and erodible soil, combined with high rainfall, there is potential for significant erosion due to baring of the soil from burning, construction of control lines or mechanical mulching".

This plan assessed the risk to soil stability from fire or fire management as follows.

- The principles of the *VFRR Reference Guide* (CFA 2010) were used as a guide.
- Based on the zoning (ESO5), soil in Pioneer Reserve is assessed as having 'High Vulnerability' on the steeper slopes.
- The likely impact of fire management works on soil stability is assessed as:

- steepest slopes (over 15 degrees): exclude works
- moderate slopes (5 to 15 degrees): resite or restrict works
- low slopes (less than five degrees): standard conditions.
  - Based on the following table, the consequences of inappropriate soil management is assessed as:
- steepest slopes (over 15 degrees): Major
- moderate slopes (5-15 degrees): Moderate
- low slopes (less than five degrees): Minor.

	Vulnerability			
Likely impact of fire mgmnt. works	**Low**	**Moderate**	**High**	**Very High**
Exclude works	Moderate	Major	Major	Catastrophic
Resite or restrict works	Minor	Moderate	Moderate	Major
Standard/no conditions	Minor	Minor	Minor	Moderate

Adapted from CFA (2010c)

Step 8:

Monitoring, learning and improving

Fire management activities should be monitored to determine:

- if management objectives (including environmental objectives) have been achieved
- if remedial work is needed to achieve objectives
- to learn from the experience and to adjust approaches (adaptive management).

Monitoring should:

- aim to collect only the data needed
- be simple and quick to carry out
- be carried out before and after operations
- be carried out in a consistent way to ensure that results from different operations can be compared
- contribute data to state-wide databases to improve their scope and accuracy.

The following plan highlights key issues to monitor for fire management plans and individual operations.

Monitoring and remediation plan

Two DSE references (Cawson and Muir 2008 and Treloar 2010) provide comprehensive guidance for monitoring fire intensity, flora and fauna.

It is suggested that when monitoring for ecological outcomes that simple visual inspections for key fire response species and fauna habitat be carried out.

Because of the specialist skills needed, it is suggested that detailed monitoring plots only be used where needed (for example, to calibrate KFRS surveys).

In addition, while photographic records are useful for reports and as memory aides, they should only be considered if there is an appropriate record-keeping system that will enable others to use them.

All monitoring records for burns and other fire management operations should be filed in accordance with SOP 9.39.

Issue to be monitored	Location	Priority	Monitoring		Remediation or follow-up	
			Specifications	Timing	Specifications	Timing
Community safety	Asset protection and strategic fire moderation zones	H	Survey for overall fuel hazard, using *Overall Fuel Hazard Guide* (DSE 2010)	Annually, preferably spring	Identify the need for changes to vegetation management to meet objectives	Following each survey
Biodiversity	All treatment sites	H	Survey for presence of significant environmental assets	Prior to operations Post operation (2 years) Post operation (5 years) Post operation (10 years)	Identify the need for changes to vegetation management operations to avoid unacceptable effects on assets Identify the need for changes to proposed fire regimes to meet objectives Contribute information to DSE's fire monitoring database, Argus (www.dse.vic.gov.au)	Following each survey
		H	Survey for key fire response species using: *Flora monitoring protocols for planned burning: a user's guide* (Cawson and Muir 2008, pp 71-74) *Protocols for monitoring fauna habitat structure Version 0.12 (*Treloar 2010)	At the commencement of this plan to establish baseline Prior to operations Post operation (2 years) Post operation (5 years) Post operation (10 years)	Confirm the need for fire or appropriate ecological disturbance Identify the need for changes to proposed fire regimes to meet objectives Contribute information to DSE's fire monitoring database, Argus (www.dse.vic.gov.au)	Following each survey
		H	Survey for fire severity using *Flora monitoring protocols for planned burning: a user's guide* (Cawson and Muir 2008, pp 71-74)	Post operation (2-6 weeks) Post operation (2 years) Post operation (5 years) Post operation (10 years)	Determine the response of vegetation to fire intensity Identify the need for changes to proposed fire regimes (e.g. intensity and season) to meet objectives Contribute information to DSE's fire monitoring database, Argus (www.dse.vic.gov.au)	Following each survey
Erosion	All treatment sites	H	Visual inspection	Immediately after operation, then quarterly	Rehabilitate temporary control lines Implement sediment control to minimise risk of sedimentation of waterways	Before significant rain
Weeds		H	Visual inspection	Prior to operation	Washdown of all machinery before entering reserve and upon moving between grassed and native areas	Before operation
		H	Visual inspection	Immediately after operation, then quarterly	Control weeds	Before significant rain/spring growth
Pests/ disease		H	Visual inspection for onset of disease	Annually	Washdown of all machinery (using registered disease control product)	Before entering reserve
Ongoing relevance of plan		H	Review for completeness and relevance, based on monitoring data collected	Annually/following any changes to state-wide policy or if a new house is built within 150 metres	Identify the need for changes to the plan to meet the overall objective	Annually or following changes

References

Bradstock, Williams and Gill (2002). *Flammable Australia.*

Cary, Lindemayer and Dovers (eds) (2003). *Australia burning.*

Catchpole, Bradstock, Choate, Fogarty, Gellie, McCarthy, Marsden-Smedley (1998). *Co-operative Development of Equations for Heathland Fire Behaviour*. Proc. 3rd Int. Conf. Forest Fire Research and 14th Conf. on Fire and Forest Meteorology, Coimbra, Portugal, pp 631-645.

Cawson and Muir (2008). *Flora monitoring protocols for planned burning: a user's guide.* www.dse.vic.gov.au

Cheal (2010). *Growth stages and tolerable fire intervals for Victoria's native vegetation data sets*. Fire and adaptive management report 84. www.dse.vic.gov.au

Coates, Lunt and Tremblay (2006). *Effects of disturbance on population dynamics of the threatened orchid Prasophyllum correctum D.L. Jones and implications for grassland management in south-eastern Australia*. Biological Conservation 129 (2006) 59-69.

Commissioner for Environmental Sustainability (2008). State of the environment report. www.ces.vic.gov.au

Collett and Neumann (2003). *Effects of repeated low-intensity fire on the invertebrates of a mixed eucalypt foothill forest in south-eastern Australia.* Research Report No. 61. www.dse.vic.gov.au

Counsel Assisting the 2009 Victorian Bushfires Royal Commission (2010). Roads and roadsides. Submissions of Counsel Assisting.

http://www.royalcommission.vic.gov.au/getdoc/959c7dd7-e1ee-4532-bd5e-e2e20578e3ec/SUBM-800-001-0001

CFA (2001a). *Grassland curing guide*. www.cfa.vic.gov.au

CFA (2001b). *Roadside fire management guidelines*. www.cfa.vic.gov.au

CFA (2003). *CFA environmental care policy.* www.cfa.vic.gov.au

CFA (2004a). *Herbicide policy*. www.cfa.vic.gov.au/publications/policy.htm

CFA (2004b). *Herbicide use (fire prevention) guideline*. www.cfa.vic.gov.au/publications/policy.htm

CFA (2004c). *Roadside program case study. Hamilton Highway project*. www.cfa.vic.gov.au

CFA (2004d). *Roadside program case study. Kirkstall* Phalaris *eradication project*. www.cfa.vic.gov.au

CFA (2004e). *Roadside program case study. South West Area fire prevention database.* www.cfa.vic.gov.au

CFA (2005a). *CFA Chief Officer's Standing Order 16: Environmental care.*

CFA (2005b). *CFA Chief Officer's Standard Operating Procedure 9-28: Strategy and tactics.*

CFA (2005c). *Property bushfire preparation and native vegetation management. Case study 1*. www.cfa.vic.gov.au

CFA (2007a). *CFA roadside fire management works. CFA guidelines and procedures.* www.cfa.vic.gov.au

CFA (2007b). *On the land. Agricultural fire management guidelines*

CFA (2009a). *Chief Officer's Standard Operating Procedure: Procedures for planning a prescribed burn or burn off.* SOP 9.39 – Version 1.

CFA (2009b). *Chief Officer's Standard Operating Procedure: Procedures for conducting a prescribed burn or burn off.* SOP 9.40 – Version 1.

CFA (2010a). *Fire Ready Kit*. www.cfa.vic.gov.au

CFA (2010b). *Building in a Wildfire Management Overlay. Applicant's workbook 2010.* www.cfa.vic.gov.au

CFA (2010c). *Victorian fire risk register reference guide.*

CFA (2011). *Rail corridor fire management works. CFA guidelines and procedures.*

CFA and DSE (2005). *Supervision of machinery used in wildfire operations. Learning manual. Edition 1.*

CFA and DSE (2008). *Property bushfire preparedness and native vegetation management project pilot tool kit (draft).*

CSIRO (undated). *Fire danger and fire spread calculator.* www.csiro.au

Department of Climate Change and Energy Efficiency (2010). *Australian national greenhouse accounts. National inventory report 2008, Volume 1.* www.climatechange.gov.au

Department of Environment, Sport and Territories (1994). *Fire and Biodiversity. The effects and effectiveness of fire management.* Biodiversity Series, Paper no. 8.

Department of Natural Resources and Environment (1993). *Flora and Fauna Guarantee Action Statement 17. Striped Legless Lizard. Delma impar*. www.dse.vic.gov.au

Department of Natural Resources and Environment (1999). *Flora and Fauna Guarantee Action Statement no. 53*. *Western (Basalt) Plains Grassland community.* www.dse.vic.gov.au

Department of Natural Resources and Environment (2002a). *Victoria's native vegetation management: A framework for action*. www.dse.vic.gov.au

Department of Natural Resources and Environment (2002b). *Healthy rivers, healthy communities and regional growth – Victorian river health strategy.* www.dse.vic.gov.au

Department of Sustainability and Environment (2003). *Flora and Fauna Guarantee Action Statement 182. Central Gippsland Plains Grassland, Forest Red Gum Grassy Woodland, Northern Plains Grassland, South Gippsland Plains Grassland, Western (Basalt) Plains Grassland.* www.dse.vic.gov.au

Department of Sustainability and Environment (2004a). *Guidelines and procedures for ecological burning.* www.dse.vic.gov.au

Department of Sustainability and Environment (2004b). *Vegetation quality assessment manual – Guidelines for applying the habitat hectares scoring method*. Version 1.3. www.dse.vic.gov.au

Department of Sustainability and Environment (2006). *Code of fire management for public land. Revision no 1.* www.dse.vic.gov.au

Department of Sustainability and Environment (2007). *DSE species list.*

Department of Sustainability and Environment (2007). *Advisory list of threatened vertebrate fauna in Victoria – 2007.* www.dse.vic.gov.au

Department of Sustainability and Environment (2008a). Fire management manual 10.1. Prescribed burning. Department of Sustainability and Environment.

Department of Sustainability and Environment (2008b). *Native vegetation offsets*. Victoria Planning Provisions Practice Note. www.dse.vic.gov.au

Department of Sustainability and Environment (2009a). *Floral vital attributes database*. Department of Sustainability and Environment.

Department of Sustainability and Environment (2009b). *Fire ecology strategic directions 2009-2011.* www.dse.vic.gov.au

Department of Sustainability and Environment (2009c). *Securing our natural future: Victoria's land and biodiversity white paper.* www.dse.vic.gov.au

Department of Sustainability and Environment (2009d). *Flora and Fauna Guarantee Act 1988 processes list.* www.dse.vic.gov.au

Department of Sustainability and Environment (2009e). *Flora and Fauna Guarantee Act 1988 threatened list.* www.dse.vic.gov.au

Department of Sustainability and Environment (2009f). *Floral vital attributes database*

Department of Sustainability and Environment (2009g). *Draft management of fuel breaks on medium and high conservation roadsides.* Draft report.

Department of Sustainability and Environment (2009h). *Vital attributes categories.* Department of Sustainability and Environment.

Department of Sustainability and Environment (2009i). *EVC to EVD lookup file*. Department of Sustainability and Environment.

Department of Sustainability and Environment (2010a). *Securing our rivers for future generations. Victorian river health program report card 2002-2009*. www.dse.vic.gov.au

Department of Sustainability and Environment (2010b). *Victoria's biodiversity strategy 2010–2015 consultation draft.* www.dse.vic.gov.au

Department of Sustainability and Environment (2010c). *About fire ecology – an overview*. www.dse.vic.gov.au

Department of Sustainability and Environment (2010d). *Bushfire Rapid Risk Assessment Team (BRRAT) biodiversity assessment process user manual v4.*

Department of Sustainability and Environment (2010e). *Overall fuel hazard guide*. www.dse.vic.gov.au

Department of Sustainability and Environment and CFA (2008). *Guideline for planning and designing fire control lines. Version 1.*

EPA (2002). *Ambient air quality NEPM monitoring plan Victoria.* Publication 763. www.epa.vic.gov.au

EPA (2009). *Air monitoring report 2008*. Publication 1281. www.epa.vic.gov.au

EPA, DNRE and CFA (2001). *Draft state environment protection policy (air quality management) background paper: prescribed burning, waste burning and air quality.* Publication number 749. www.epa.vic.gov.au

Fischer and Lindenmayer (2002). Small patches can be valuable for biodiversity conservation: two case studies on birds in southeastern Australia. *Biological Conservation* 106: 129-136.

Gill (2008). *Underpinnings of fire management for biodiversity conservation in reserves. Fire and adaptive management*. DSE report no. 73.

Gooding (2008). *Lessons from the Australian Interface: Reconciling bushfire risk with biodiversity conservation objectives in a regulatory system and the role of community engagement programs*. Proceedings International Bushfire Research Conference 2008. www.knowledgeweb.afac.com.au

Government of Victoria (2003). *Final report from the ministerial taskforce on bushfire recovery*. www.dse.vic.gov.au

Government of Victoria (2008). *Living with fire strategy.* www.dse.vic.gov.au

Government of Victoria (2009). *State fire management strategy.* www.ifmp.vic.gov.au

Government of Victoria (2009). *Securing our natural future. A white paper for land and biodiversity at a time of climate change*. www.dse.vic.gov.au

Hall (1994). The effects of fuel reduction burning on forest soils. In *Fire and Biodiversity. The effects and effectiveness of fire management*. Department of the Environment, Sport and Territories. Biodiversity Series, Paper no. 8.

Halliday (2010, draft). *Management and maintenance of fire regimes across private conservation lands*. Thesis submitted as partial fulfilment for the Degree of Bachelor of Science (Honours). Griffith University.

Hawke (2009b). The Australian Environment Act. *Final report of the independent review of the Environment Protection and Biodiversity Conservation (EPBC) Act 1999.* www.environment.gov.au

Hennessy, Lucas, Nicholls, Bathols, Suppiah, and Ricketts (2005). *Climate change impacts on fire-weather in south-east Australia.* Report C/1061. CSIRO, Melbourne.

Hill and Bull (2008). *Cooperative management of grasslands for fire safety and the environment.* Paper presented to the 2008 AFAC Conference.

Humphreys and Craig (1981). *Effects of fire on soil*. In *Fire and the Australian Biota*. Gill, Groves and Noble (eds). Australian Academy of Science.

Kennedy and Jamieson (2007). *Ecological fire management in North East Victoria.* In: Tassie Fire Conference; 18-20 July, Hobart, Tasmania.

Lumsden and Bennett (2005). Scattered trees in rural landscapes: foraging habitat for insectivorous bats in south-eastern Australia. *Biological Conservation* 122: 205-222.

MacHunter, Menkhorst and Lloyn (2009). *Towards a process for integrating vertebrate fauna in fire management planning*. Technical Report 192. http://www.dse.vic.gov.au/arthur-rylah-institute/publications/reports#topic107313

McCarthy and Chatto (1998). *Heathlands burning prescriptions for Victorian heathlands. Research Report 49.* Department of Natural Resources and Environment.

McCarthy and Tolhurst (1998). *Effectiveness of firefighting first attack operations by the Department of Natural Resources and Environment from 1991/92 to 1994/95*. Research report no. 45. Department of Natural Resources and Environment, Victoria.

Marsden-Smedley and Catchpole (1995). Buttongrass Moorland fire

behaviour modelling in Tasmanian Buttongrass Moorlands II. Fire Behaviour. *International Journal of Wildland Fire*: 1995 (4), pp215-228.

Morgan and Lunt (1999). Effects of time-since-fire on the tussock dynamics of a dominant grass (Themeda triandra) in a temperate Australian grassland. *Biological Conservation* 88, pp379-386.

Nillumbik Shire Council (2010). Fire as a management tool requires careful consideration. *Fringe Focus*. Winter 2010, pp 9-10.

obliqua pty ltd (2010). Bushfire management and environmental obligations – options paper. Report to CFA.

obliqua pty ltd and Oates Environmental Consulting Pty Ltd (2009). *Fire management plan: Baths Road Reserve Mirboo North*. Report to South Gippsland Shire Council.

obliqua pty ltd and Oates Environmental Consulting Pty Ltd (2009). *Fire management plan: 'Woodfield', Meerlieu.*

obliqua pty ltd and Oates Environmental Consulting Pty Ltd (2010). *Fire management plan: Professors Hill Reserve Warrandyte North*. Report to Nillumbik Shire Council.

obliqua pty ltd and Oates Environmental Consulting Pty Ltd (2011b). *Fire management plan: Pioneer Reserve, Kongwak*. Draft report to South Gippsland Shire Council.

obliqua pty ltd, Oates Environmental Consulting Pty Ltd, INVERT-ECO, and Ecoplan Australia (2011). *Fire management plan: Eltham Copper Butterfly Reserves, Eltham*. Draft report to Nillumbik Shire Council.

Standards Australia/Standards New Zealand (2006). *HB 203:2006. Handbook. Environmental risk management – principles and process.*

Standards Australia/Standards New Zealand (2009). *AS/NZS ISO 31000:2009. Risk management – principles and guidelines.*

Suckling (1982). Value of reserved habitat for mammal conservation in plantations. *Aust. For.* 45, 19-27.

Tolhurst (1994). Effects of fuel reduction burning on fuel loads in a dry sclerophyll forest. In *Fire and Biodiversity. The effects and effectiveness of fire management*. Biodiversity series. Paper no. 8, pp17-20. Department of the Environment, Sports and Territories.

Tolhurst (2008). *Fire behaviour calculations for southern Australia*. *August 2008.*

Tolhurst (2010a). *Setting and achieving fire management objectives*. Course notes. 22-410 Bushfire planning and management course. University of Melbourne.

Tolhurst (2010b). *Objectives, prescriptions, burning and monitoring.* Course handout. 220-410 Bushfire planning and management course. University of Melbourne.

Tolhurst and Cheney (1999). *Synopsis of the knowledge used in prescribed burning in Victoria.* Department of Natural Resources and Environment.

Tolhurst and Howlett (2003). *House Ignition Likelihood Index – A hazard assessment method for land managers in the wildland-urban interface.* 10th AFAC Conference and 4th International Wildland Fire Conference, Sydney, Australia.

Tolsma, Cheal and Brown (2007a). *Ecological burning in box-ironbark forests. Phase 1 – literature review.* Report to North Central Catchment Management Authority. Department of Sustainability and Environment.

Tolsma, Cheal and Brown (2007b). *Ecological burning in box-ironbark forests. Phase 2 – management strategy. Report to North Central Catchment Management Authority*. Department of Sustainability and Environment.

Treloar (2010, in prep). *Protocols for monitoring fauna habitat structure. Version 0.12.* Department of Sustainability and Environment.

University of Ballarat, Treed Environs, Julie von Platen and Biodiversity Services (2009). *Roadside condition mapping and fire management prescriptions for selected Strategic Fire Management Roads within the south of the Corangamite Shire*. Report to Corangamite Shire.

URS (2007). *The economic value of benefits provided by Victorian rivers.*

van der Ree, Bennett, and Gilmore (2004). Gap-crossing by gliding marsupials: thresholds for use of isolated woodland patches in an agricultural landscape. *Biological Conservation* 115: 241-249.

Victorian Bushfires Royal Commission (2009). *Final Report*. www.royalcommission.vic.gov.au

Victorian Catchment Management Council (2007). *Victorian catchment condition report.* www.vcmc.vic.gov.au

Victorian Environmental Assessment Council (2010). *Remnant native vegetation investigation discussion paper*. www.veac.vic.gov.au

Victorian Rail Industry Environmental Forum (2007). *Vegetation management guidelines for rail corridors*. www.victrack.com.au

Appendices

Appendices are numbered to refer to the step in which they are first identified. For example, Appendix 3-1 is the first appendix relevant to Step 3 in the Guide.

Appendix 1-1

Legal and policy framework

This appendix provides a brief overview of the legal and policy framework for environmental sustainability. CFA personnel can obtain further information from the obligations register, which forms part of CFA's environmental management system. Copies of legislation can be viewed at www.austlii.edu.au

Environment Protection and Biodiversity Conservation Act 1999

It is an offence under Part 3 to undertake actions that cause a "significant impact" on matters of national environmental significance without the prior permission of the Federal Minister for the Environment. Listed matters include threatened species or communities (s18, 18A) and migratory species (ss20, 20A). "Significant impact" is not defined in the EPBC Act, but in separate guidelines. Prior approval of the Minister is required before undertaking activities that may have an impact on matters of significance (Part 9).

Flora and Fauna Guarantee Act 1988

Section 4(2) of the Flora and Fauna Guarantee Act 1988 provides that a public authority (including councils) "must be administered so as to have regard to the flora and fauna conservation and management objectives".

These are to:

(a) guarantee that all taxa of Victoria's flora and fauna other than the taxa listed in the Excluded List can survive, flourish and retain their potential for evolutionary development in the wild

(b) conserve Victoria's communities of flora and fauna

(c) manage potentially threatening processes

(d) ensure that any use of flora or fauna by humans is sustainable

(e) ensure that the genetic diversity of flora and fauna is maintained

(f) provide programs of community education, co-operative management of flora and fauna and conservation incentives

(g) encourage the conserving of flora and fauna through co-operative community endeavours.

Permits may be required (under Part 6) for removal (killing, removal or destroying) of protected flora.

Environment Protection Act 1970

It is an offence to discharge waste into water (s38, 39), air (s40, 41), or onto land (s44) unless in accordance with declared state environment protection policy or other policy.

Planning and Environment Act 1987

The objectives of planning in Victoria include the "protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity".

The Planning and Environment Act regulates native vegetation clearance through the requirement to obtain a permit (clause 52.17 of the Victoria Planning Provisions (VPPs)).

The VPPs specify a number of circumstances in which native vegetation may be removed, destroyed or lopped for fire protection.

Changes to the Victoria Planning Provisions are expected to be introduced in September 2011 in response to recommendations of the 2009 Victorian Bushfires Royal Commission.

Land and biodiversity policy

The Land and Biodiversity White Paper (Government of Victorian 2009b) outlines new policy and legislation to achieve the following vision over the next 50 years: "Victorians acting together to ensure that our land, water and biodiversity are healthy, resilient and productive". A key goal is to "safeguard Victoria's land, water and biodiversity by building ecosystem resilience, maintaining ecosystem services and improving connectivity".

Appendix 1-2

Sources of information – fire history

The following table lists additional information and sources that may help you to complete Step 1.

Issue	Information	Source
Fire history	Fire ignition points and reported data, e.g. area, type of fire	CFA Fire and Incident Reporting System (FIRS)
	Fire ignition density spatial layer	CFA GIS
	Fireplan interactive map	DSE website
	Firemap	Fireweb
	Fire ecology assessments for public land	Parks Victoria fire ecology planning officers
	Local knowledge	Land manager, newspapers, CFA brigade, historical society
	Field assessment	Charcoal

Appendix 2-1

Sources of information – provisional community safety proposals

The following table lists additional information and sources that may help you to complete Step 2.

Issue	Information	Source
Risk assessment and treatment	Houses and properties	*Fire ready kit* (CFA 2010a) *Wildfire Management Overlay site assessment kit* (CFA 2010b) *On the land* (CFA 2007b) *Home retrofit guide* (Building Commission and CFA 2010)
	Linear corridors	*Roadside fire management guidelines* (CFA 2001b) *Roadside fire management works guidelines and procedures* (CFA 2007a) *Rail corridor fire management works guidelines* (CFA 2011)
	Landscape-scale planning, e.g. local area or municipal	*Victorian fire risk register reference guide* (CFA 2010c), which includes a risk rating tool
Fire likelihood	Likely ignition sources	Fire history records (refer to Appendix 1-2)
	Frequency of fires	
	Potential for fire spread to assets	Fire behaviour and spread prediction tools include: *Municipal fire risk register*, *Overall fuel hazard guide* (DSE 2010e), *Grassland curing guide* (CFA 2001a), firemap fuel load layer for EVC (DSE website), Tolhurst (2008), CSIRO fire danger and fire spread calculator, Catchpole et al (1998, heath), McCarthy and Chatto (1998, heath) and Marsden-Smedly (1995, Button Grass), weather records including fire danger ratings Potential fire suppression success: CFA plans including pre-incident plans and township protection plans, *Overall fuel hazard guide* (DSE 2010e) Table 9.1
Fire consequences	Threat posed by fuel hazard	Fire behaviour and spread prediction tools (refer above) Bushfire Attack Level (BAL) or radiant heat exposure (AS 3959:2009) *House Ignition Likelihood Index* (Tolhurst and Howlett 2003)
	Vulnerability (including preparation of properties and community to respond appropriately to fire)	*Municipal fire risk register* Site assessment

Appendix 3-1

Sources of information – environmental assets

The following table lists additional information and sources that may help you to complete Step 3.

Notes:

1 EPBC listed vegetation communities do not necessarily align to EVCs. Advice from DSE biodiversity officers may be needed to align boundaries.

2 The ABC database contains information on approximately one-third of all significant species in Victoria.

Environmental asset	Information	Source
All	Assistance with implementing Step 3	DSE biodiversity officer, municipal conservation officer or other expert
	Significant assets (broad scale and in progress)	Municipal fire risk register
Ecological Vegetation Classes	EVC descriptions Spatial data: Biodiversity Interactive Map Vegetation quality (habitat hectares) EVC benchmarks	DSE website, native vegetation page DSE website, interactive map page DSE (2004b) DSE website, native vegetation page
Bioregional Conservation Status of each EVC	EVC Bioregional Conservation Status Spatial data: Bioregions: VBIOREG100 (1:100,000) Bioregional Conservation Status: NV2005_EVC_BCS (1:100 000) Biodiversity Interactive Map	DSE website, native vegetation page DSE DSE DSE website, interactive map page
Ecological Vegetation Divisions	EVCs assigned to EVDs EVD list and descriptions Spatial data: Ecological Vegetation Divisions (EVDs)	DSE 2009i Cheal 2010 DSE
Listed communities	EPBC Act listed communities (1) FFG Act listed communities Flora Information System Action statements and recovery plans Research and survey papers Expert local knowledge (including DSE biodiversity officers)	DSEWPC website DSE DSE DSEWPC and DSE websites
Listed species	EPBC Act listed species FFG Act listed species ABC database (2) Flora Information System Victorian Fauna Database Action statements and recovery plans Research and survey papers Expert local knowledge (including DSE biodiversity officers) Spatial data: Threatened flora: THFLO100, THFLO100, EVC_BCS Threatened fauna: THFAU100 Biodiversity Interactive Map	DSEWPC website DSE website DSE website DSE search available DSE search available DSE website DSE DSE DSE website, interactive map page
Biological significance (biosites)		DSE
Rainforest	RAINFOR100 (1:100 000) RFSOS100 (sites of significance)	DSE
Wetlands	RAMSAR100 (1:100 000) WETLAND_1994 (Current wetlands) Wetlands DIR100 (Victorian Wetlands listed in *A Directory of Important Wetlands in Australia*)	DSE
Alpine peatlands		DSE
Reference areas		DSE
Forest management	Special protection zones (SPZs) and old growth forest locations from FMZ100 (Forest Management Zones)	DSE
Long-term research projects		DSE
Land for Wildlife properties	LFW100	DSE
Trust For Nature Properties		Trust for Nature
Native vegetation offset sites	Ecotender, Bush Tender sites	DSE
Biolinks		DSE (Government of Victoria 2009)

Appendix 3-2

Environmental assets – conservation status assigned in the Native Vegetation Framework

Source: DSE (2002a) Native Vegetation Framework

CONSERVATION SIGNIFICANCE	VEGETATION TYPES		OR SPECIES	OR OTHER ATTRIBUTES
	Conservation status	Habitat score		
VERY HIGH	Endangered	0.4 – 1	Best 50% of habitat for each threatened species in a Victorian bioregion	Sites with unique National Estate values Sites identified as being of national significance as a relict, endemic, edge of range or other non-species Ramsar sites East Asian-Australasian Shorebird Site Network sites, other wetlands of international significance for migratory waterbirds areas identified as providing refuges (e.g. during drought) for threatened species
HIGH	Endangered Vulnerable Rare	< 0.4 0.3 – 0.5 0.3 – 0.6	The remaining 50% of habitat for threatened species in a Victorian bioregion Best 50% of habitat for rare species in a Victorian bioregion	Sites with rare National Estate values Sites identified as being of state significance for relictual, endemic, edge of range or other non-species values Wetlands listed in *A Directory of Important Wetlands in Australia* Wetlands of national significance for migratory waterbirds Areas identified as providing refuges (e.g. during drought) for rare species Priority areas for re-establishment of habitat for a threatened species (e.g. as determined in Biodiversity Action Plan)
	Depleted	0.6 – 1		
MEDIUM	Vulnerable Rare Depleted Least Concern	< 0.3 < 0.3 0.3 – 0.6 0.6 – 1	The remaining 50% of habitat for rare species in a Victorian bioregion Best 50% of habitat for regionally significant species	Sites with uncommon National Estate values Sites identified as being of regional significance for edge of range or other non-species values Wetlands of bioregional significance (based on application of National Land and Water Resources Audit criteria)
LOW	Depleted Least Concern	< 0.3 < 0.6		

Appendix 4-1

Sources of information – environmental effects

The following table lists some information and sources that may help you to complete Step 4.

Issue	Information	Source
All	Assistance with implementing Step 4	DSE biodiversity officer, municipal conservation officer or other expert
Pest plants	Integrated Pest Management System spatial layers Prohibited Weed List Invasive Plants List Advisory List of Environmental Weeds Flora Information System ABC database Expert advice	DPI DPI DPI DSE DSE DSE DPI, DSE, council
Pest animals	Integrated Pest Management System spatial layer Wildlife Atlas of Victoria Expert advice	DPI DSE DPI, DSE, council
Pathogens	*Phytophthora cinnamomi* distribution Expert advice	DSE DSE
Assessing the level of risk		*VFRR reference guide* (CFA 2010c)

Appendix 5-1

Sources of information – treatments

The following table lists some information and sources that may help you to complete Step 5.

Issue	Information	Source
All	Assistance with implementing Step 4	DSE biodiversity officer, municipal conservation officer or other expert
Works	Environmental effects and treatments	*Roadside fire management guidelines* (CFA 2001b) *Vegetation management guidelines for rail corridors* (Victorian Rail Industry Environmental Forum 2007) *Guideline for planning and designing fire control lines* (DSE and CFA 2008) *Supervision of machinery used in wildfire operations. Learning manual. Edition 1* (CFA and DSE 2005)
Pest plants and animals	ABC database Expert advice	DSE Council, DPI and DSE
Pathogens	Expert advice	DSE

Appendix 6-1

Sources of information – improving biodiversity

The following table lists some additional information and sources that may help you to complete Step 6.

Step	Information	Source
All steps	**Ecological fire needs for vegetation on rural land (where it may have similar requirements to vegetation on public land)**	**PV fire ecology planning officers**
6.1 Vegetation classification	**Ecological Vegetation Classes (EVCs)** **EVC descriptions** **Spatial data: Biodiversity Interactive Map**	**DSE website, native vegetation page** DSE website, interactive map page
	EVCs assigned to EVDs Ecological Vegetation Divisions (EVDs) and Ecological Fire Groups (EFGs) Lists and descriptions	DSE 2009i Cheal 2010
6.2 Appropriateness of fire	Expected fire behaviour for EVDs	Cheal 2010 (Table 2.3)
6.3 Indicator species	Flora: Vital attributes database	DSE 2009f
	Fauna: MacHunter et al (2009)	DSE website
6.4 Fire intervals	Tolerable fire interval table	Cheal 2010 (Table 2.5)
6.5 Needs of indicator and significant species		Refer to Step 6.3
6.6 'Ideal' fire frequency	History of fire	Refer to Appendix 1-2
	History of other disturbance, e.g. grazing/logging	Land manager, other local knowledge
	Growth stages	Cheal 2010 (sections 3 and 4)
	Area likely to be burnt by bushfire	Refer to Appendix 2-1

Appendix 6-2

Description of tools – improving biodiversity

The following table provides additional information and sources that may help you to complete Step 6.

Tools	About these tools	Step	Source
Ecological Vegetation Class (EVC) maps and descriptions	Used to classify native vegetation into approximately 300 categories based upon common ecological characteristics.	6.1 Vegetation classification	DSE, native veg. page DSE, interactive map page
EVC to Ecological Vegetation Division (EVD) tables	Used to group EVCs that share similar responses to fire. There are 32 EVDs as at 2010.		DSE 2009i
Ecological Fire Groups (EFGs) tables	Used to subdivide EVDs to distinguish different fire response characteristics such as minimum tolerable fire intervals within the EVD.		Cheal 2010 (Table 2.5)
Expected fire behaviour for EVD tables	Used to describe the fire behaviour expected in each EVD.	6.2 Appropriate ness of fire	Cheal 2010 (Table 2.3)
Floral vital attributes database	The floral vital attributes database summarises life history characteristics of each plant species including time to reproduction and extinction. Using these attributes, those species most susceptible to variation in fire regime (key fire response species) can be used to identify fire needs and to monitor the impact of fire. This tool is under continuing development.	6.3 Indicator species	DSE 2009f
Faunal key fire response species (KFRS) table	The faunal key fire response species table lists species most susceptible to variation in fire regime (key fire response species) for 16 of the current 32 EVDS. This tool is under continuing development.		MacHunter et al 2009 (Appendix 4)
Tolerable fire interval table	This table lists the minimum and maximum recommended time intervals between fire for each EVD. The time interval is derived from the vital attributes of plant and animal species that occupy the vegetation community. The TFIs guide shows how frequent fires should be in the future to allow the persistence of all species at the site or defined area.	6.4 Fire intervals	Cheal 2010 (Table 2.5)

Appendix 6-3

Legend for floral vital attributes table

Major category	Category state
Seed response (PERSEED)	D – widely dispersed, seed available at all times after fire
	S – long-lived seed bank, seed stored, partial germination after fire
	G – long-lived seed bank, complete germination after fire
	C – short-lived seed bank, exhausted after single disturbance
	Z – does not re-establish from seed immediately (or soon) after fire
Vegetative response (PERVEG)	V – sprouters, all ages survive, but all become juvenile
	U – sprouters, mature remain mature, juvenile remain juvenile
	W – sprouters, mature remain mature, juveniles die
	N – sprouters, mature become juvenile, juveniles die, or there are no juveniles before the fire
	X – does not resprout post-fire
	Y– sprouters, mature become juvenile (i.e. non-reproductive), juveniles die, or there are no juveniles before the fire
Establishment conditions (TIRMK)	T = tolerant, can establish immediately after fire and in later years as vegetation ages, right through to mature and over-mature vegetation (assuming suitable seasonal conditions)
	I = intolerant, able to establish immediately after a fire (within the first two seasons and usually within the first season), but cannot continue recruitment as the vegetation ages further, unable to establish in mature vegetation
	R = unable to establish immediately after fire (within the first season or two), but can establish in older vegetation (including mature to over-mature vegetation), requires some environmental characteristics not found in vegetation straight after fires
	M = can only establish at an intermediate stage, i.e. cannot establish straight after fire or in mature to over-mature vegetation
	K = establish immediately after fire and also in mature to over-mature vegetation, cannot establish in intermediate-aged vegetation

Major category	Category state
Time to reproduction (JUVEN)	< 1 year
	1-2 years
	3-5 years
	5-10 years
	10-20 years
	20-40 years
	> 40 y
Extinction time (SPP LIFE)	≤ 3 y
	3-10 years
	10-20 years
	20-50 years
	> 50 years (score as 100)
Plant life span (INDIV LIFE)	A = Annual
	ASP = annual or short-lived perennial
	B = Biennial
	SP = short-lived perennial
	MP = medium-lived perennial
	LP = long-lived perennial
GEOPHYTE	YES
	NO
KFRS	1 (Highly suitable)
	2 (Suitable)
	3 (Somewhat suitable)
	NS (Not suitable)
ALL	F = inadequate data
Data Source	[in parentheses – data source noted but inconsistent with other data and overruled]
Remarks	(in parentheses – refers to data source)

Source: DSE (2009h)

Appendix 7
Abbreviations

BOM	Bureau of Meteorology
Biosite	Site of biological significance
CMA (NRCA)	Catchment Management Authority
CaLP Act	Catchment and Land Protection Act 1994
CAMBA	China Australia Migratory Bird Agreement
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
DPCD	Department of Planning and Community Development
DPI	Department of Primary Industry
DSE	Department of Sustainability and Environment
EMO	Erosion Management Overlay
EP Act	Environment Protection Act 1970
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESO	Environmental Significance Overlay
EVC	Ecological Vegetation Class
EVD	Ecological Vegetation Division
FFG	Flora and Fauna Guarantee Act 1975
FIS	Flora Information System
IFMP	Integrated Fire Management Plan
LSIO	Land Subject to Inundation Overlay
JAMBA	Japan Australia Migratory Bird Agreement
MAV	Municipal Association of Victoria
MFPC	Municipal fire prevention committee
MFPO	Municipal fire prevention officer
MFPP	Municipal fire prevention plan
MSS	Municipal strategic statement
NES	Matter of national environmental significance
NRCA	Natural Resources and Catchment Authority (from June 2011) to replace CMAs and coastal boards
NVPP	Native vegetation precinct plan
OESC	Office of Emergency Services Commissioner
PV	Parks Victoria
SLO	Significant Landscape Overlay
SMO	Salinity Management Overlay
SPPF	State Planning Policy Framework
SPZ	Special protection zone (forest management plans)
VicRoads	Government agency that manages the Victorian arterial road network
VicTrack	Government rail agency
VPO	Vegetation Protection Overlay
VPP	Victorian planning provisions
WMO	Wildfire Management Overlay

Appendix 8
Glossary

Key sources include VEAC (2010), Cheal (2010)

Adaptive management

A systematic process for continually improving management by learning from the outcomes of programs (based on monitoring) and incorporating new information in programs.

Airshed

A geographic area that is being investigated or managed for air pollution control.

Biodiversity

The variety of all life forms, including different plants, animals and micro-organisms, encompassing their genes, species, ecosystems and their interactions.

Biota

The living components (fauna and flora) of an ecosystem or habitat. (Abiotic refers to non-living components).

Biolinks

Broad geographic areas managed to increase ecological function and connectivity, improving the potential of plants and animals to disperse, recolonise, evolve and adapt.

Bioregion

Large, geographically distinct areas of land characterised by landscape-scale natural features and environmental processes that influence the function of entire ecosystems. Bioregions are defined by physical characteristics such as geology, landforms and climate.

Canopy

The canopy (crown) of the tallest plants, which typically comprises a layer or multiple layers of branches and leaf foliage.

Coarse woody debris

Dead woody material, in various stages of decomposition, located above the soil, larger than 7.5 cm in diameter which is not self-supporting (e.g. not a tree or stump).

Connectivity/landscape connectivity

The degree to which landscapes actually assist or restrict the movement of organisms and processes.

Corridors

Strips of habitat that differ from the adjacent land on both sides and connect two or more habitat areas. See also 'wildlife corridor', below.

Country area of Victoria

That part of Victoria which lies outside the metropolitan fire district, but does not include any forest, national park or

protected public land (CFA Act 1958 s3).

Disturbance

Any event that disrupts ecosystem, community or population structure and changes resources or the physical environment. The disruption event may be natural such as fire, snow, disease, wind, earthquake or flood or artificial in origin including timber harvesting, prescribed burning, slashing, clearing or pollution.

Ecological processes

The interactions and connections between living and non-living systems including movements of energy, nutrients and species.

Ecological Fire Group (EFG)

A subdivision of Ecological Vegetation Divisions (EVDs)

(see below) to distinguish different fire response characteristics such as minimum tolerable fire intervals within the EVD. The EFG fields will be progressively updated as necessary.

Ecological Vegetation Class (EVC)

A native vegetation classification based upon common ecological characteristics. There are approximately 300 EVCs as at 2010.

Ecological Vegetation Division (EVD)

A classification of native vegetation based on groups of EVCs that share similar responses to fire. There are 32 EVDs as at 2010.

Ecosystem

A system functioning together as a unit that includes all living organisms, the physical components of the environment and their relationships.

Ecosystem resilience

The ability of a system to absorb and recover from disturbance while retaining the same basic function.

Ecosystem services

The services provided by the environment that sustain human life, including a stable climate, clean air, water cycling and purification, nutrient cycling, soil formation, biomass production, waste disposal, crop pollination, provision of food and minerals, and the maintenance of genetic diversity.

Edge effects

Changes in conditions that occur at an ecosystem boundary.

Endemic

A species that is native to a single geographic region and is found nowhere else.

Environmental impact

Any change to the environment, whether adverse or beneficial.

Environment

For the purposes of this Guide, 'environment' is defined as air, water, land and biodiversity.

Exotic species

Species occurring outside their historic natural range as a result of dispersal by human activities.

Erosion

The wearing away of land surface by wind, water, land clearing practices or other natural or man-made processes.

Extinction

The end of a species, or the end of a species in a defined area ('local extinction'). The moment of extinction occurs with the death of the last individual of that species and loss of all means of reproducing (e.g. depletion of seed bank).

Fauna

Animal life of any particular region or time.

Fire cycle

Length of time for an area equal to the entire area of interest to burn.

Fire dependent

Refers to species or vegetation types that depend on a particular aspect of the fire regime for their establishment, growth or persistence. For example, some fire-dependent flora species may have seeds that only germinate after stimulation by heat or smoke.

Fire ecology

The component of fire management involving the study of fire and its interaction with the natural environment (often focusing on biodiversity).

Fire exclusion

The policy of suppressing bushfires or prohibiting the use of planned burning in a defined area.

Fire frequency

Number of fires per unit time in a specified area.

Fire intensity

The heat energy released in a fire expressed as kW/m of fire front.

Fire interval

Time (in years) between two successive fires in a designated area.

Fire Protected Area (FPA)

Any land that is within any state forest, national park or protected public land or unless excised, within 1.5 kilometres of these land categories (adapted from Forests Act 1958).

Fire or fire management regime

Seasonality, frequency, intensity, type and extent of fire or fire management over a prolonged period.

Floodplain

Lands adjacent to waterways that are subject to flooding.

Flora

The plant life occurring in a particular region.

Flow regime

The pattern of changes in the season, timing, frequency, volume, rates of rise and fall, and duration of flows in a waterway. The flow regime or hydrology influences the physical nature of river channels, the biological diversity, and the key processes that sustain the aquatic ecosystem and ecosystem services.

Geophyte

Plants that have underground food stores (e.g. bulbs, corms, rhizomes, tubers).

Germination (in plants)

The process by which a seed begins to sprout and grow into a seedling.

Habitat

The physical space within which a species lives and the organisms with which it interacts.

Habitat degradation

The reduction in quality or condition of an area of habitat for a given species that affects the survival of individuals or populations of the species.

Habitat fragmentation

Functional separation of habitat patches for a given species.

Habitat loss

Loss of habitat for a given species from an area, which prevents a species from persisting there.

Habitat quality

The ability of an area to provide conditions appropriate for survival of individuals and populations of a species. One measure of habitat quality is the 'habitat hectare', which scores the condition of the site (including modification and recruitment of vegetation and the presence of litter and coarse woody debris) and the landscape context (patch size and connection to habitat) (DSE 2004b).

Key fire response species (KFRS)

Those species (plant or animal) whose vital attributes (life history characteristics, see below) indicate that they are vulnerable to a fire regime of frequent fires or to long periods of fire exclusion.

Landscape

The visible features of an area of land.

Native vegetation

Vegetation that is dominated by locally indigenous species.

Recolonisation

The restoration of a population to an area within its range.

Refugia

Places that escape or are minimally affected by disturbance and provide habitat until more favourable conditions return.

Resilience

The capacity of a system to absorb disturbance to retain essentially the same function, structure and feedback loops.

Riparian

Relating to or located on the banks of a river or stream.

Risk (see also environmental impact)

The chance of something happening that will have an impact on objectives. Risk is measured by the consequences (outcome or impact) of an event and their likelihoods. Risk may have a positive or negative impact.

Seed bank

Dormant seeds that are capable of germination if the right conditions appear. The seed bank may be on the plants, in fruit or in, or on, the soil.

Seral (or growth) stages

The series of distinct changes in vegetation communities as they develop during succession from bare ground or immediately post-fire to mature vegetation, and beyond (see also 'Succession').

Succession (stages)

The process of continuous (re-)colonisation (and extinction) of populations at a particular site as vegetation ages and is replaced.

Sustainable fire management

For the purposes of this Guide, environmentally sustainable fire management meets community safety objectives (protecting life and property), while:

- avoiding or, if that is not possible or practical, minimising harm to the environment including the quality of air, land, water and biodiversity
- maintaining or improving biodiversity (through regime management), where practical
- using regime management to reduce the occurrence and intensity of bushfire across the landscape
- meeting legal and policy obligations for environmental care.

Threat (see also environmental impact and risk)

Person or thing likely to cause damage or danger.

Threatened species

Species or communities that are in danger of becoming extinct and whose survival is unlikely if the factors that are causing rarity continue. There are a number of different classifications of the threat level depending upon whether the species/community is listed internationally, nationally or at a state level. Classifications use terms such as rare, vulnerable, endangered, critically endangered and presumed extinct to indicate the level of threat.

Tolerable fire interval (TFI)

A term that expresses the minimum or maximum recommended time intervals between fire for a vegetation community. The time interval is derived from the vital attributes of plant and animal species that occupy the vegetation community. The TFIs guide how frequent fires should be in the future to allow the persistence of all species at the site or defined area.

Vegetation remnant

Patch of native vegetation remaining after an area has been cleared or modified.

Vital attributes

Vital attributes summarise life history characteristics such as growth patterns, reproduction method and life history stages. Using these attributes, those species most susceptible to variation in fire regime (key fire response species (see above)) can be used to identify fire needs and to monitor the impact of fire.

Wetlands

Areas featuring permanent or temporary shallow open water that does not exceed a depth of six metres at low tide. They include billabongs, marshes, swamps and lakes.

Wildlife corridor

Components of the landscape that facilitate the movement of species and processes between areas of intact habitat.